Cyprus University of Technology

Faculty of Fine and Applied Arts

Doctoral Dissertation

CROSS-ORGANIZATIONAL COMMUNITIES OF PRACTICE IN DESIGN STUDIES: ENHANCING CREATIVITY, COLLABORATION AND PRE-PROFESSIONAL IDENTITIES IN HIGHER EDUCATION

Aekaterini Mavri

Limassol, November 2020

CYPRUS UNIVERSITY OF TECHNOLOGY

FACULTY OF FINE AND APPLIED ARTS

DEPARTMENT OF MULTIMEDIA AND GRAPHIC ARTS

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Approval Form

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ACKNOWLEDGMENTS

What a journey it has been!

A journey dedicated to communities which empower students to make their transition from academia to the industry, oddly enough, coming from a person who made this transition in reverse order, a decade ago. This has not only been a journey of research, but of personal development, maturation, and discovery, that would have not been possible without the help of quite a few people.

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To my parents, Zacharias and Niki. This is for you.

ABSTRACT

The purpose of this work is to investigate the role and impact of cross-organizational (industry-academia) Communities of Practice (CoPs) on learning in Higher Education (HE) Design studies. CoPs are groups of people who share a common interest in an area of 'endeavor' and connect to co-create knowledge through practice.

This dissertation is motivated by the current gap between academia and industry, regarding the actual – versus the anticipated – knowledge, skills (communication, collaboration, creativity) and personae (vocational relevance) of graduates who transition into the digital creative industries today. This originates from the graduates' lack of authentic experiences with real-life practice, as well as from the universities' limitation to keep up with the fast-paced industry developments.

This research proposes that robust academia-industry collaborations can enhance academic programs towards bridging this gap. It demonstrates the effective convergence of creativity, collaboration, and authenticity in education through cross-organizational CoPs, by bringing together academic and industrial stakeholders in a technology-supported and curriculum-integrated practice. Following a mixed-methods approach, it captures a diverse body of data to understand and explain the designed and emergent learning phenomena. Findings denote solid member participation levels, made evident in the abundant online and offline CoP exchanges. They also infer significantly higher epistemic and creative outcomes for CoP-participating - versus non-participating - students. The substantial shift in learner perspectives and perceptions of achievement signifies an identity transformation, from the academic toward the pre-professional and professional statuses, induced by the broader membership and context of the CoP.

This work empirically demonstrates and validates the critical interlocking of the *technological*, *epistemic* and *social* designs that constitute an appropriate learning ecology for the complex practices of cross-organizational CoPs in HE Design studies. It also provides a structured set of actionable guidelines to assist researchers and practitioners in the adoption of the cross-organizational CoP model, in an aim to enhance learning in the Design disciplines.

Keywords: Communities of practice, situated learning, creativity, vocational relevance, academia-industry collaboration

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LIST OF ABBREVIATIONS

CUT:	Cyprus University of Technology
HE:	Higher Education
CoP	Community of Practice
VCoP	Virtual Community of Practice
LoP	Landscape of Practices
LPP	Legitimate Peripheral Participation
HCI	Human Computer Interaction
WDD	Web Design & Development
UCD	User Centered Design
PBL	Problem Based Learning
ACAD	Activity Centered Analysis & Design
URL	Uniform Resource Location
FTP	File Transfer Protocol
IDE	Integrated Development Environment
CST	Creativity Support Tool
GUI	Graphical User Interface
UIC	University Industry Collaboration
MM	Mixed Methods
MFD	Multiphase Design
DBR	Design-Based Research
LMS	Learning Management System
MOOCs	Massive Online Open Courses
RQ	Research Question

N	Number
M	Mean
SD	Standard Deviation

1 Introduction

This chapter aims to inform the reader about the scope of this doctoral dissertation. It commences by introducing the background and relevant problems which form the motivation for this work. Through a brief review of the surrounding research, it then identifies a number of knowledge gaps and consequent research objectives, and explains how the research design aims to address these objectives within the context of three phases and six studies. It concludes by outlining the structure of the dissertation.

1.1 Problem Statement

A few years ago, the McKinsey report (2013) defined two related issues, namely, unemployment and a shortage of human capital with critical job-appropriate skills, as two of the major global crises with severe socio-economic consequences today. Related literature primarily attributes this to insufficient communication, and lack of relevance and uniformity between the academia and industry, with regard to the learning objectives, approaches, and evaluation criteria that apply in each one (L. Leung & Bentley, 2017; Turbot, 2015). An additional cause of this gap concerns issues of timing, as the industry moves at an accelerated pace, due to its sprinting technological and business advancements, causing education-based practices to fall behind, and rendering them somewhat isolated from the real-world (Oguz & Oguz, 2019).

As such, the inadequacy of the graduate human capital to fulfill new employment demands which go beyond subject knowledge, to include creativity, communication, collaboration, critical thinking, real-world vocational relevance, and aptitude for practice, is substantial (Becker et al., 2017; L. Leung & Bentley, 2017), and evidently, "universities are not delivering" (Mulgan et al., 2016).

Relevant literature stresses that such "changing demands by employers require a paradigm change in higher education" (Chamorro-Premuzic, 2019), whereby academic institutions are called to focus on cultivating soft skills and a sense of curiosity for *authentic* problems, which have proven to be key indicators of future career potential. These directions have instigated the concept of a challenge-driven university model (Mulgan et al., 2016), which aims for deeper learning through cross-disciplinary and cross-organizational (university-industry) communication. According to this, the authenticity of the unpredictable and complex real-world problems, as well as the opportunity to collaborate with external stakeholders - although challenging – can effectively steer curiosity, creativity and collective experimentation in learning (Becker et al., 2017).

Communication, *collaboration* and *creativity,* together with *critical thinking*, represent the 4Cs of the P21 (21st century skills) framework (Guo & Woulfin, 2016, 2009) which gathered considerable research attention over the past two decades (Dobreva, 2016; Guo & Woulfin, 2016; Lombardi, 2007; Price et al., 2010; Stephanidis et al., 2019; Warr & O'Neill, 2005; Zhu et al., 2016). In fact, critical thinking and creativity have been presented as entangled, since critical judgments require approaching problems from alternative perspectives, examining multiple scenarios and 'imagining' *several* resolutions; reflecting a *critico-creative* type of thinking (Choueiri & Mhanna, 2013; Fisher, 2011). Acknowledging their importance, the NMC Horizon 2017 report stated that "colleges and universities must rethink how to define, measure, and demonstrate subject mastery and soft skills such as creativity and collaboration" (Becker et al., 2017).

The case of *creativity*, has reportedly been under-investigated in Higher Education (HE) thus far for two main reasons. Firstly, defined as *the expression or outcomes that are novel and appropriate for a purpose*, it is a complex and multifaceted construct, that constitutes its cultivation and evaluation in HE challenging to pursue (Allee, 2000; Hennessey, 2017; Hildreth & Kimble, 2004; V. R. Lee, 2014). Secondly, creativity research has been largely dominated by notions of the creative individual, leaving important concepts of the 'We-paradigm' (collaborative or distributed creativity), considerably underexplored (Crilly & Cardoso, 2017; Glăveanu, 2014; V. R. Lee, 2014; Scott, 2015). Similarly, there is dearth in work with a focus on technology-supported creativity, in the context of *human-computer* and *human-human* interaction studies (Hoffmann, 2016; Shneiderman et al., 2006; Stephanidis et al., 2019).

As such, distributed or collaborative *creativity* and *real-world relevance,* are crucial within the scope of this work. Not only are they imperative for the transition of graduates into today's creative knowledge economies, but are also inherently linked to the *digital creative industries* that epistemically frame this research. Defined as the convergence of IT, programming, interactive media and business (L. Leung & Bentley, 2017; Proctor-Thomson, 2013), the digital creative industries subsume all Design disciplines. Literature has over the years provided an extended collection of areas that make up the Design disciplines, comprising engineering, architecture, computer science, HCI, information design, industrial design, urban design, educational and instructional design, as well as the performing arts, and presented the need for a domain-independent Design theory with appropriate research characteristics and practices (Nelson & Stolterman, 2014; Zimring & Craig, 2001). As such, the people involved in these disciplines (designers) practice design thinking (a cyclical inspiration, ideation, and implementation process), aim towards both creative and innovative solutions that are suitable for a purpose, while critically relying on technology to drive their iterative, collaborative and human-centered processes, in an effort to address real-world complex problems (Gabriel et al., 2016; Nguyen et al., 2016; Strobel et al., 2013).

Considering the critical link of the 4Cs to the digital creative industries, Wijngaarden et al. (2019) posited that literature still lacks a “shared conceptualization of innovation” within these domains, rooted in the same reasons that concern *creativity*; that is, the difficulty in grasping and measuring the multi-dimensional nature of the creative processes and outcomes in these domains, and their “unique qualities and opportunities associated with tertiary education in this area” (L. Leung & Bentley, 2017).

Within this context, it is important to note that as creative outcomes present both *novelty* and *appropriateness* for real-world problems, *authenticity* thus becomes a crucial component of all creative activity (Amabile, 1982; Sternberg & Grigorenko, 2001). Authenticity, in education, reflects learning which is informed by ill-defined real-life problems, industry-university collaborations, diverse (i.e. external) assessment based on industry resources and criteria, and the development of useful products for the real world (Bhatnagar & Badke-Schaub, 2017; J. S. Brown et al., 1989a; Herrington et al., 2014; Lombardi, 2007). In the same vein, creativity theorists have stressed the importance of *authentic social judgement* for the evaluation of innovative outcomes. This, therefore, defines creativity as highly situated within the context of its use, the purpose it serves, and the stakeholders it involves (Hennessey, 2017).

Following this rationale, with the aim to foster creativity in education, the past few years have seen the rise of more forward-thinking approaches such as active, collaborative and computer-supported collaborative learning (CSCL) and work

(CSCW). Instructional methods have also shifted towards problem-based learning, peer-assisted learning, gamification, the flipped classroom approach and similar others, in an attempt to encourage deeper and more creative learning outcomes (De Smet et al., 2008; Dillenbourg et al., 2009; Duch et al., 2001; L. A. Gibson & Sodeman, 2014; Hwang et al., 2015; Weinberger & Fischer, 2006). Importantly, initiatives to de-isolate education and establish an open dialogue with the professional community to cultivate - amongst others – real-world *work relevance* for scholars, have also emerged (Albats, 2018; Jackson, 2016; Mourshed et al., 2013; Talone et al., 2017). The Horizon 2019 report (Alexander et al., 2019) claims that such partnerships have materialized mostly in the context of university-based venture labs, incubators and other initiatives involving the commercialization of research ideas into products. Aside of these being largely located in research, they often materialize as part of isolated events, such as industry-led workshops and competitions. For instance, the Texas A&M university's school of engineering organizes yearly 48-hour design challenges as partnering events, to promote innovation and cultivate entrepreneurial skills for students, through the collaboration of faculty and industry stakeholders (Aggies, 2020). However, albeit beneficial, such initiatives tend to transpire outside the curriculum (Alexander et al., 2019).

That said, the recent years have seen the slow rise of university-industry collaborations (UICs) which aim to enhance education, across a number of different disciplines (i.e. communication, nursing, business, engineering), universities (i.e. University College London IXN, DHBW - Baden-Württemberg Cooperative State University), and countries. While the benefits of UICs are indisputable, relevant reports state that "this trend has not yet seen wide penetration in higher education" (Becker et al., 2017). Moreover, the UIC research landscape is evidently in need of a sound theoretical lens through which researchers can examine the multi-level and multi-perspective phenomena that emerge in such diverse contexts (Albats, 2018). We further argue that literature is still lacking well-tested and validated models, underpinned by rigorous theories, which place particular emphasis on the *educational* perspectives of UICs, to frame and evaluate these initiatives (Ivascu et al., 2016).

In response to this call, this work asserts that Communities of Practice (CoPs) lends itself as one such theory, which enables researchers to understand the convergence of the two organizational spheres within a unified learning space, toward enhanced academic and post-academic goals. CoPs originate from Situated Learning, a theory which supports that knowledge cannot materialize outside the authentic context - be it conceptual, social or technical – it is meant to be applied in (J. S. Brown et al., 1989a). CoPs refer to groups of people who are driven by a common interest, passion, and goals in a shared area of 'endeavor, who come together to co-create knowledge and competence in that area (Lave & Wenger, 1999a). As such, a CoP constitutes "a living curriculum for the apprentice" (E. Wenger, 1998), providing opportunities for novices to participate in, observe and imitate more competent others, enabling them to learn informally as *legitimate* and socially situated members of a common practice (Lave & Wenger, 1999b; E. Wenger, 1998).

By adopting and expanding the theory with a *cross-organizational* dimension, CoPs can transcend the boundaries of distinct organizational spheres - academia or industry - toward various targeted learning aims (Kezar et al., 2017; E. Wenger et al., 2009). Specifically, this work proposes that participation in a cross-organizational CoP which is integrated into the HE curriculum, can help students (as prospective graduates) respond to new industry demands; these call for creative competence and outcomes, diverse communication and collaboration skills, and real-world vocational relevance, as the critical workforce qualities of today (Albats, 2018; Iskanius & Pohjola, 2016; Perkmann et al., 2013). Their development instigates the formation of a *pre-professional identity*, which according to Jackson (2016) involves "an understanding of and connection with the skills, qualities, conduct, culture and ideology of a student's intended profession".

We base this proposition on what we currently know through existing research reporting on the positive contribution of CoPs in educational and industrial settings (A. DeChambeau, 2017; Fegan, 2017; J.-F. Harvey et al., 2015; J. Y. Park, 2015; Pharo et al., 2014; Power & Armstrong, 2017; Probst & Borzillo, 2008; Pyrko et al., 2017; Tight, 2015). By bringing together stakeholders from both organizational spheres - students, faculty, alumni mentors, industry experts, and clients - as co-members in a CoP, we posit that formal HE programs can be infused with *authenticity*; that is, informing formal education with the real-world problems, needs, trends and methods, and enriching it with external evaluation practices which comply with industry standards and expectations (Albats, 2018; Bhatnagar & Badke-Schaub, 2017; Ivascu et al., 2016; Lombardi, 2007).

To date, CoP research has taken an *intra-organizational* approach, concentrating on either academic or professional contexts alone (Crossouard & Pryor, 2008; A. DeChambeau, 2017; Stone et al., 2017). Conversely, research reporting on the role of *cross-organizational* CoPs in HE is limited to none. However, the CoP-supported link between education and practice, at times when industry-university alliances are increasingly endorsed by academic institutions, is a critical step for innovation – both for education and research - that cannot be overlooked. Work investigating the design of cross-organizational CoPs, their social structure and dynamics, and their epistemic processes and outcomes, is literally absent from literature (Perkmann et al., 2013). Several authors have also stressed the need to understand these dimensions in the context of more targeted investigations. They specifically called for a classification of CoPs, in terms of their *structure/scale* (i.e. small-scale, public), *scope* (i.e. academic, industry, or cross-organizational), and *purpose* (i.e. learning, networking, knowledge sharing, and management), as well as the particular *disciplinary* context they evolve in (Amin & Roberts, 2008; A. DeChambeau, 2017; U. Smith et al., 2017), as opposed to a 'one-fits-all' approach (Dubé et al., 2005; Hsu et al., 2007). Additionally, the need to understand online or blended Cops, in terms of their technology configuration and its adoption by members in support of their practice, signifies another direction in CoP research (Shneiderman, 2000; Spagnoletti et al., 2015). It is worth noting that technology is particularly critical in cross-organizational CoP initiatives, as it can mediate the authentic practice by minimizing the disparities of its heterogeneous membership (university-industry), from a geographical, temporal and cultural perspective.

1.2 Research Purpose

Taking the step to integrate a cross-organizational CoP in the HE curriculum, requires a holistic approach - a *CoP ecology* per se – to its design and evaluation. Guided by the aforementioned gaps in knowledge, this work thus employs the Activity Centered Analysis and Design (ACAD) framework (see section 2.5.1) to structure its top-level analysis, focusing on the specific *epistemic* planning, the appropriate *social* structure, and the distinct *technology configuration* to serve the needs of CoPs in the specific academic field. Within the scope of this work, we focus on the HE Design studies (encompassing disciplines such as Engineering, Architecture, Technology, and HCI), the relationships of which have been previously explained (L. Dym et al., 2005).

As such, the overarching aims of this research are to:

a) Provide comprehensive evidence of the CoP's ecology *design*, *enactment* and *evaluation*, from the *social*, *epistemic* and *technology* perspectives. In doing so it aims to validate the *cross-organizational CoP* model within the context of Design studies in HE.

b) Derive practical *governance mechanisms* and offer an affordable and transferable *cross-organizational model* for enhancing CoP-based learning ecologies toward similar objectives.

This work investigates these overarching aims across three phases and six studies, which address a set of more targeted research questions. These are explained in the following section.

1.3 Research Design and Questions

Based on the needs of this research and supporting bibliography (see chapter 2, 'Conceptual framework') on CoP-related research methodologies, a multi-face, mixed methods (MM) research design was adopted in this work (see Figure 1). Since social learning theories are oriented towards the research problem, as a *socio-cultural phenomenon*, they follow both exploratory and confirmatory approaches (inductive and deductive forms of logic) across various cycles of investigation, to form a well-rounded grasp of this (Teddlie & Tashakkori, 2009). In doing so they examine the *effects* of CoPs through scale and comparison based on quantitative data, and approach the *experiential* dimensions of learning through a vertical approach, that is, diving into a deeper examination of the emergent phenomena, through qualitative investigation (B. Wenger-Trayner et al., 2019).

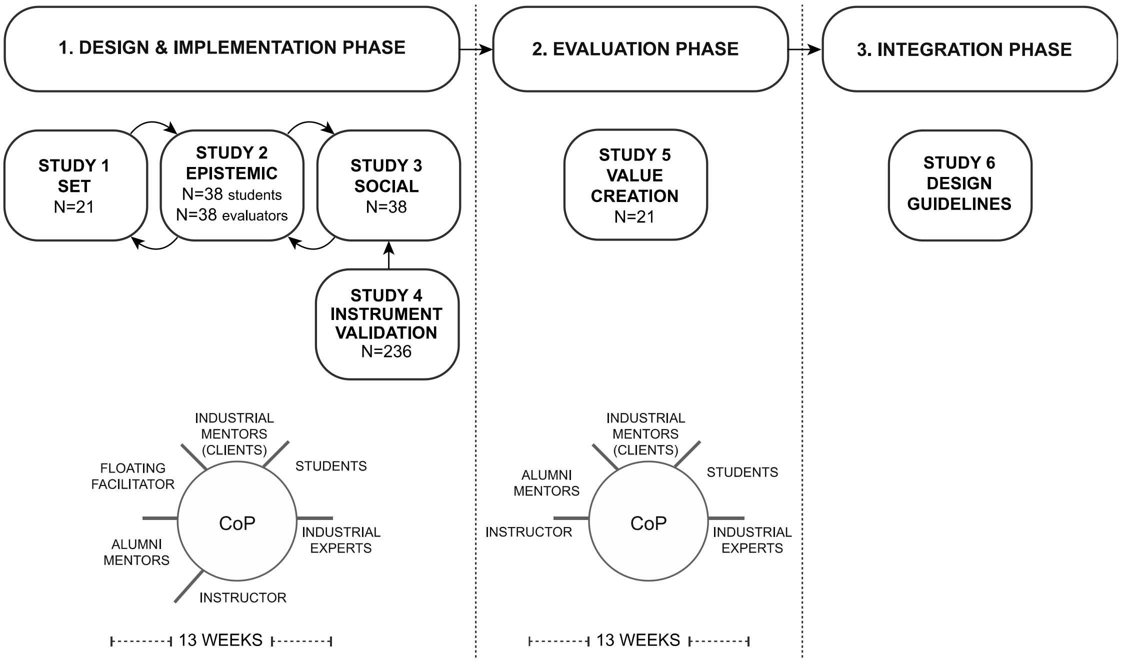


Figure 1: Multi-phase research design, studies, participants, and CoP structure

The multi-phase design (MFD) in this case, subsumes a series of parallel and sequential data collection cycles, that either balance quantitative and qualitative investigation or prioritize one over the other, based on the different research questions and the respective findings serving to inform subsequent phases. The individual studies' primary research objectives can be seen in Figure 2. They evolve across three broad sequential phases, namely the *Design & Implementation*, *Evaluation*, and *Integration* phases, described next.

Phase 1, *Design & Implementation,* informs about the design, enactment and evaluation of the cross-organizational CoP ecology which is appropriated to the needs of Design studies in HE, concerning:

a) The *technological* setup, through study **1**, which is guided by the following primary research question:
"*What constitutes an appropriate technology configuration design for cross-organizational CoPs in HE Design studies, based on the respective technology adoption findings?"*
b) The *epistemic design* and *creative outcomes,* through study **2**, which is guided by the following primary research question:

"What constitutes an appropriate epistemic design for cross-organizational CoPs in HE Design studies, based on the learners' actual and perceived epistemic and creative outcomes?"

c) The *social collaboration* in the CoP practice, through study **3**, which is guided by the following primary research question:
"How does participation in a cross-organizational CoP affect the generated feedback, the creative collaboration and outcomes, as well as the experiences of learners in HE Design studies?"

d) The reporting on the *validation* of the psychometric properties of an instrument, employed to gauge learner perceptions of their creative collaboration (in study 3), through study **4**, which is guided by the following primary research question:
"What is the factor structure of a psychometrically valid instrument for the measurement of creative collaboration and what are the conceptual relationships between the items in these factors?"

Phase 2, *Evaluation*, evaluates the overall impact of cross-organizational CoP participation on the *learning value* and the development of learners' pre-professional *identities*, through study **5**, which is guided by the following primary research question:

"How does participation in a cross-organizational CoP influence the value of learning, and consequently, the pre-professional identities of learners in HE Design studies?"

Specifically, this study involves further data collection, combined with findings from phase **1**, which are analyzed using the Value Creation framework (see section 2.5.2), to draw inferences about the worth of learning, and the learner identities that were co-transformed as a result of CoP participation.

Phase 3, *Integration*, draws implications for the *design*, *implementation, facilitation* and *evaluation* of cross-organizational CoPs in the HE Design curriculum, through study **6**, which is guided by the following primary research question:

"What are the design implications for a learning ecology that can effectively integrate a cross-organizational CoP in the HE Design studies?"

Specifically, this study provides actionable guidelines to assist researchers or practitioners who wish to adopt the cross-organizational CoP model innovate by enhancing their learning environments in the HE Design disciplines.

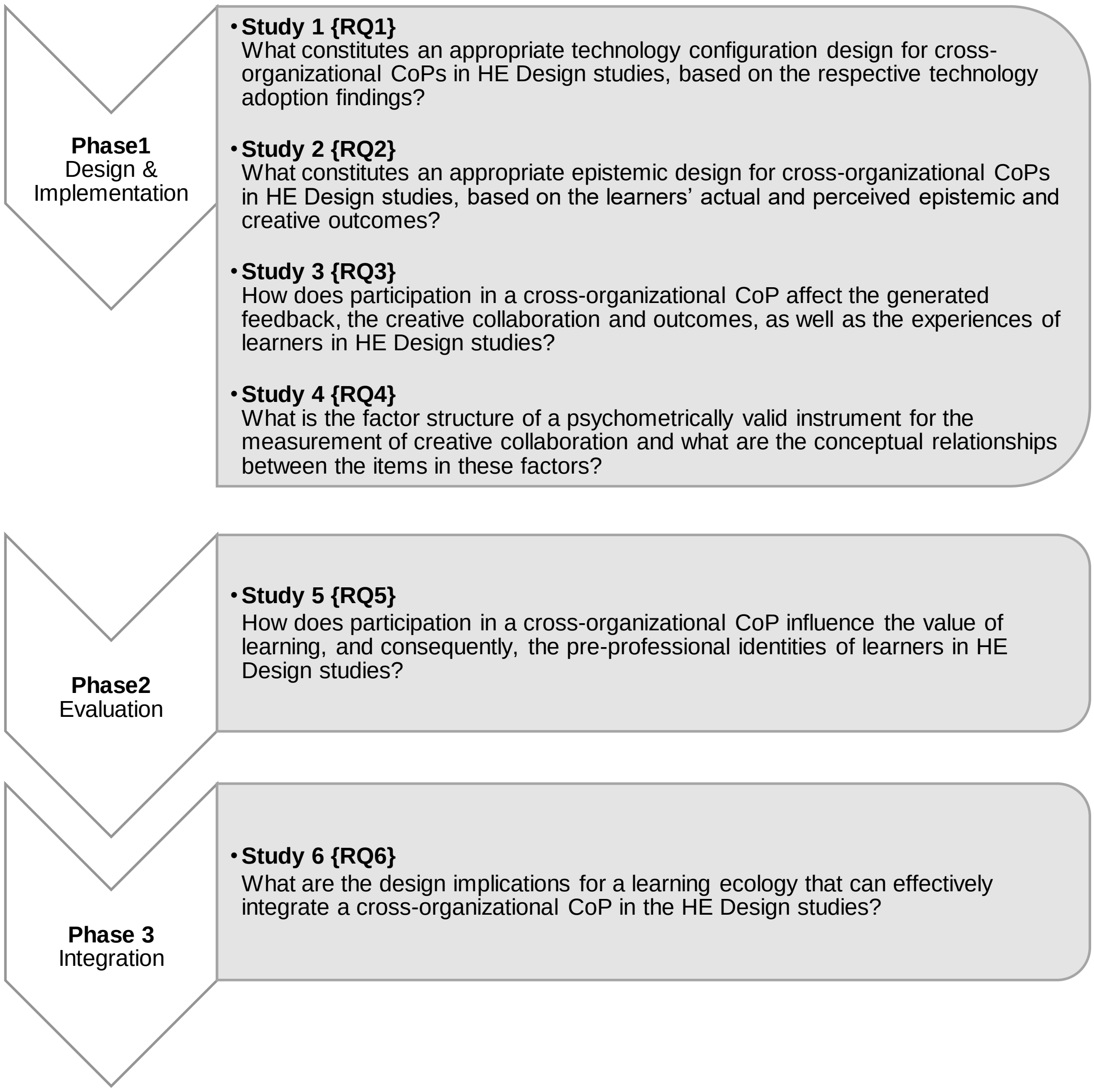


Figure 2: Phases, individual studies and research questions

1.4 Research Context: the Cross-Organizational Ecology

1.4.1 Epistemic Design (Control and Experimental Conditions)

This research involved 38 third-year university students, who enrolled in two Web Design and Development modules (WDD-1 and WDD-2), comprising 180-minute weekly lessons, which ran in two consecutive semesters (26-weeks) across an entire academic year. Guided by a User-Centered-Design (UCD) philosophy, its processes and methods (see section 3.2.3.2), the WDD modules aimed to expose learners to the

fundamentals of front-end web design and development, through the use of HTML, CSS and JavaScript technologies.
Students were divided by registration into an *experimental* (G1, N=21) and a *control* group (G2, N=17). Specifically, in terms of sampling, studies **1** and **5** involved the 21 students of the experimental group (G1) only, studies **2** and **3** (partially) employed a *quasi-experimental, between-subjects* design, involving all 38 students from both groups (G1, G2), while study **4** recruited a total of 236 local and overseas undergraduate/postgraduate students with prior experience in collaborative projects in blended or online learning settings. Further, based on individual study needs, additional participants assumed different roles. Specifically, a set of 38 participants (industry experts, alumni, clients, 4th year students, researchers) were recruited as evaluators in studies **1** and **3** (see Figure 1).

Students self-formed teams of approximately four people each, in both experimental and control groups, and were assigned a different *real-life* project each. A total of five industrial stakeholders (clients) delivered project briefs to the student teams, which involved the design and development of static websites, in semester 1, evolving into dynamic websites, in semester 2. Each project was developed twice, once by a team in the experimental group (G1) and once by a team in the control group (G2). Both groups shared identical course structure and materials, and both followed a *problem-based learning* (PBL) instructional approach (see section 2.2.3). According to this, teams were given ill-structured problems to solve in class, and were prompted to first conduct individual research, and then team up to discuss their findings, define requirements, and choose an appropriate course of action. They were also randomly asked to present and explain their outcomes in class, and prepare for peer reviews and feedback. Mini-lectures, brief workshops, and quick tips were provided by the instructor or a teaching assistant (floating facilitator) at specific stages in the process. The teams proceeded to hands-on sessions, in order to experiment with and develop their solutions, using a combination of real-time online collaboration tools and offline software. Upon task completion, the teams concluded with short demonstrations followed by Q&A sessions and discussion with peers.

In semester 2, the experimental group (G1) students worked on advancing their semester 1 (website) projects further, alongside other module assignments.

1.4.2 Social Infrastructure

A cross-organizational CoP (see Figure 3) was introduced in the experimental condition (G1) only, in both semesters. The CoP stakeholders included: a) the *instructor* of the course b) a *floating facilitator*: a graduate student as a teaching assistant for classroom and online activities (semester 1 only), c) three *alumni mentors* who provided feedback to students on project deliverables at pre-defined stages throughout the semester, d) five *industrial mentors*, as the clients who delivered the projects, resources and feedback on student work, and e) three *industrial experts* who evaluated the final website projects at the end of the semester. The experts were introduced and were made accessible to students via a Facebook group at the start of semester 1.

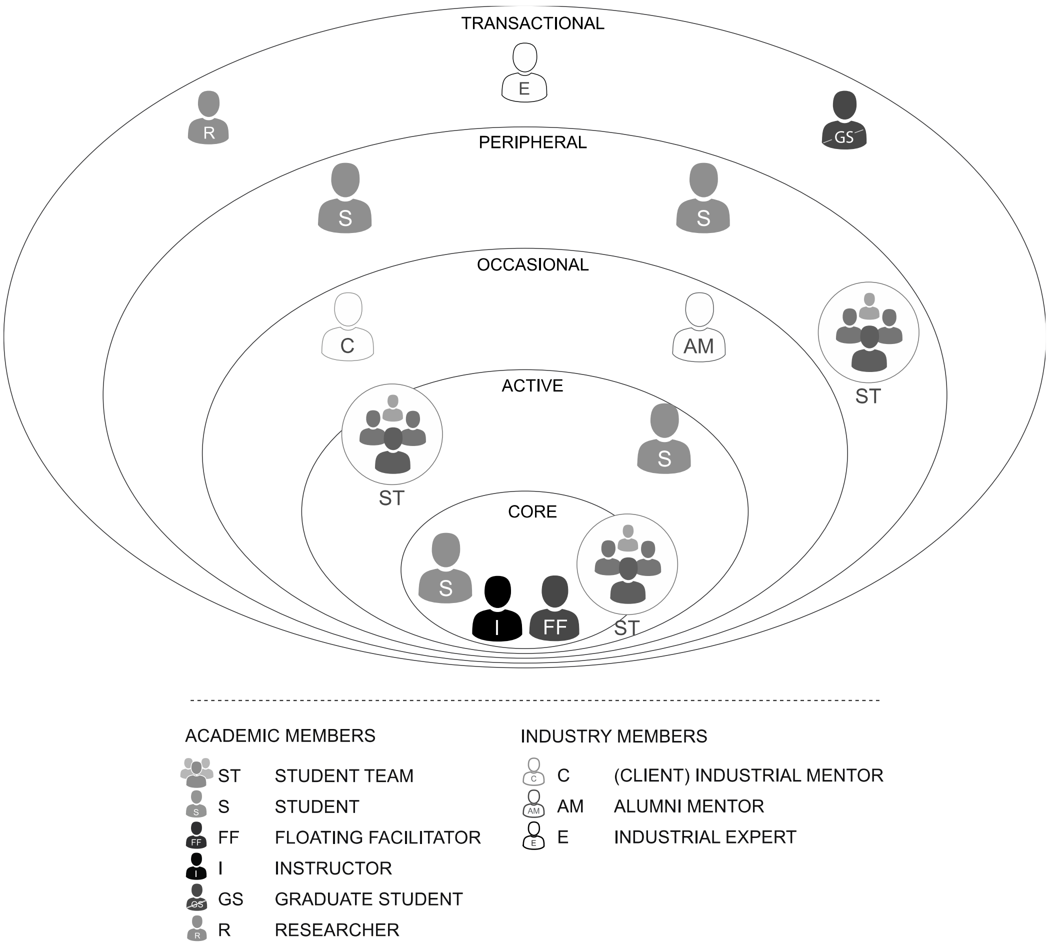


Figure 3: Semester 1 CoP social structure and levels of participation (Wenger-Trayner 2011)

Following data collection and analysis from phase 1, and in response to informal student requests, the social CoP model was modified in phase 2. Specifically a total of five *industrial experts* were invited to provide talks every two-weeks, and were responsible for evaluating students via mock job interviews, as a partial contribution to their semester 2 assessment. The role of the floating facilitator was also dropped.

1.4.3 Technology Configuration

While the physical context is important for classroom-based collaborative learning activities, this work placed emphasis on the understanding of a CoP-based ecology for *learning* and its socio-epistemic *practice* which operationalized largely through an appropriate *technology configuration* (collection of platforms, tools and features) as Figure 4 demonstrates (Carvalho & Goodyear, 2014b). Its respective components have been classified according to their *context* of *use*, as '*team-based*', '*community-wide*', and '*single-user*', as well as online/offline and synchronous/asynchronous (sync/async) contexts.

Likewise, *team-based* technologies included: a) Conceptboard, a real-time virtual collaborative canvas, used for brainstorming, card-sorting, sketching, experimentation, resource-management and artifact creation, b) Google Drive, Documents and Sheets, recommended for shared document-management and productivity purposes, c) Google Hangouts suggested for synchronous communication, and d) Adobe Dreamweaver, used for web development (coding / WISWIG modes) and a File Transfer (FTP) tool for online publishing.

Community-wide technologies included: a) Adobe's Behance, an online portfolio and social-networking platform, b) *Hypothes.is*, a page-embedded reviewing tool, and c) *Moodle*, as the learning management system (LMS) used for academic material purposes.

Finally *single-user* technologies included: a) Axure RP, used for rapid prototyping, b) Adobe Photoshop, used for digital image editing and manipulation, and c) Adobe Illustrator, used for vector graphic editing and illustration purposes.

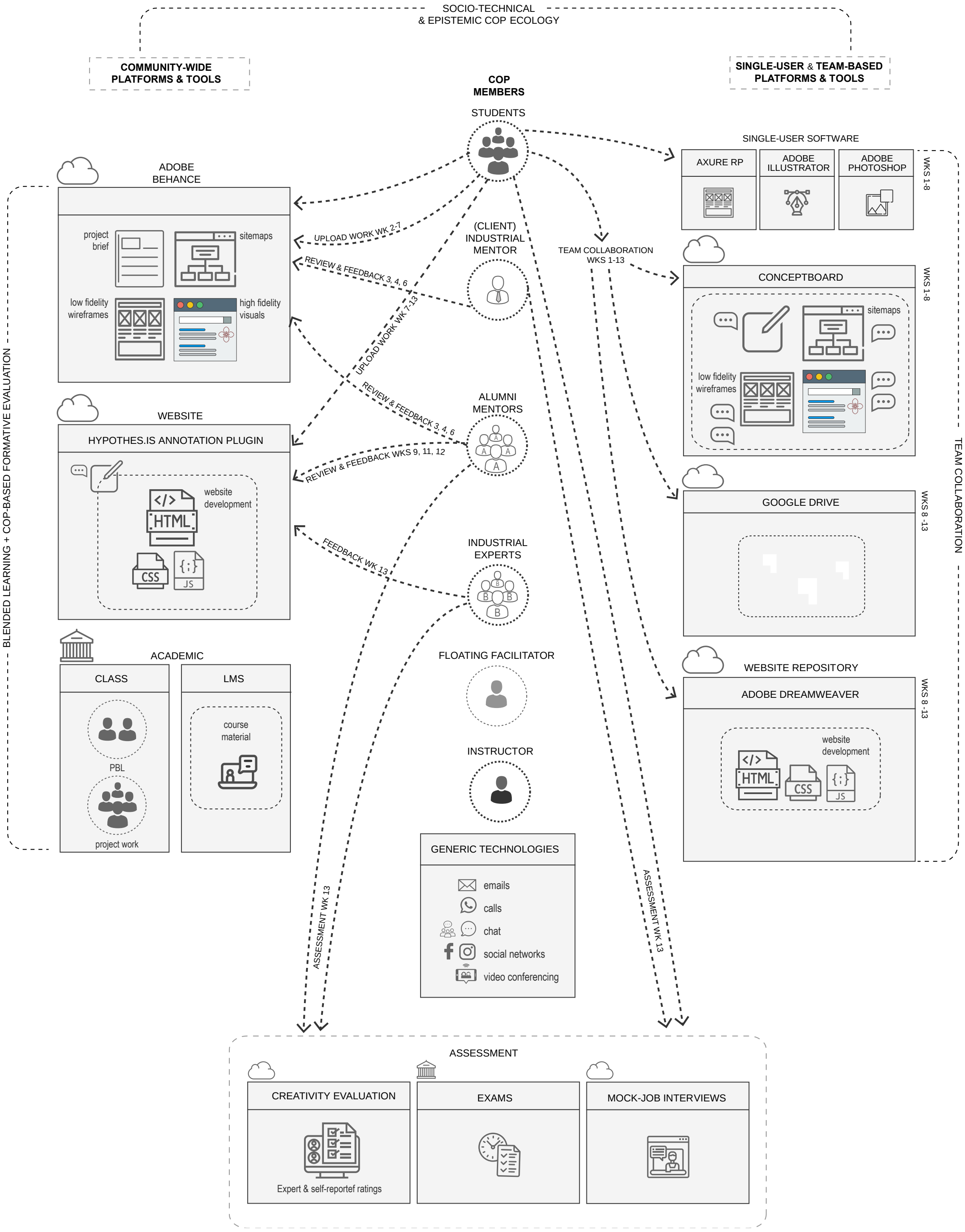


Figure 4: Cross organizational CoP ecology: *technological*, *epistemic* and *social* structure

1.5 Significance of This Dissertation

The work makes a significant contribution to the growing community of researchers and practitioners involved in *university-industry* collaborations with a focus on curriculum-integrated CoPs that aim to promote *collaboration, creativity* and *real-world vocational relevance* (Harrison et al., 2013). There are currently no studies reporting on this type of CoP model, to offer insights on how these can be *technologically* sustained, *epistemically* (learning) enacted, and *socially* practiced, in aim of the above objectives which contribute to the formation of learners' *pre-professional* identities (Albats, 2018; Ivascu et al., 2016; Perkmann et al., 2013). It's specific contributions are described below.

1.5.1 A Cross-Organizational Model

"*Provide direct exposure to professional industry practice*" (P. Brown, 2015)

The contribution of this work lies in the cross-organizational adaptation of Wenger's (1998) CoP model, in an effort to mediate the industry (processes, methods, culture, constraints, criteria) directly into the curriculum. This is critical as it can assist in a secure and progressive maturation of real-world vocational relevance and hence the formation of pre-professional learner identities, starting from the early stages of HE (Mulgan et al., 2016; A. J. Rourke & Coleman, 2009). As there is a current lack of evidence in these cross-organizational approaches within empirical CoP research, this study, in effect, validates the cross-organizational CoP model in HE.

This model provides a different way of understanding *communities,* on the cross-organizational spectrum and across a landscape of practices. It agrees with the current phenomenon of communities with stakeholders from multiple practices, with different purposes, different competences, and different meaning-making dynamics. Trying to effectively fuse these into a shared community, is challenging and uncertain. Although different interventions have specific characteristics, the contribution of this work lies in its effort to minimize the risks of 'going in blind', by providing a set of *actionable steps* to follow and prevent possible undesirable outcomes.

1.5.2 A Domain-Specific Model with a Focus on Creativity

"*Documenting the epistemic structures that need to be orchestrated*" (U. Smith et al., 2017)

Relevant literature confirms that there is scarcity in specialized CoP research, that addresses the particular socio-epistemic needs of a discipline (Amin & Roberts, 2008; U. Smith et al., 2017). This work assists in the understanding of an *epistemic* design oriented toward Design-based CoPs, and particularly how this is synched and interlocked with the *technological* and *social* infrastructure, to enable its members' collaborative processes toward the development of *creative* outcomes. This blend (epistemic design and creativity) is important, especially in the context of the Design disciplines (i.e. engineering, architecture, HCI), as these are inherently bound to *creativity* (especially, in its social *distributed* form), which is evidently another under-explored construct in educational research (S. Harvey, 2014; P. B. Paulus & Baruah, 2018).

With respect to this gap, and in line with new research directions which place emphasis on the collaborative aspects of creativity within *natural* (educational) settings (Candy, 2013; Frich et al., 2018), this work offers a validated psychometric instrument for measuring creative collaboration (ASCC) in blended learning settings. This can facilitate the evaluation of the real situated experiences of the people involved in the creative process – not within controlled (i.e. in-vitro) – but real-world settings (i.e. in class or online) (Gouvier & Musso, 2014). As such, it contributes to the research community's strive to promote and understand *creativity* in real educational settings.

1.5.3 A Practical and Replicable Model for the 'New Normal'

"*Offering suggestions instead of making laws*" (P. Goodyear, 2000)

Contributions to theory from a top-down perspective, i.e. creating new, or expanding existing theory is important. All the same, a tested and exhaustively described approach, which offers concrete actionable knowledge, is also of great practical importance. Specialized guidelines for the *social infrastructure*, the *technological configuration* and the *epistemic design*, combined with incentives and justifications of their *transferability*, can evidently serve as meaningful knowledge that designers or educational technologists can adopt to improve their learning environments (P. Goodyear, 2000).

As such, this work addresses a current situation, from the *educational* and *professional* perspectives, due to the disruption caused by the COVID-19 pandemic. Collaborators, co-workers and communities (small and informal, or large and official) are challenged to meet their *learning* and *collaboration needs*, being physically distant, relying solely on technology. This does not only reflect the present status quo, but also a *post-pandemic* 'new normal' which embeds the probability of other, similar conditions or crises (Dalsgaard, 2020). That said, it is also true that the present 'enforced' situation has highlighted the advantages (i.e. efficiency, speed, focus) of certain activities, which transpire exclusively in online environments, over their previous physically-enacted forms.

Concrete and validated evidence on how CoPs can be designed and steered to enable learning/work coordination, address social isolation, and facilitate knowledge-sharing and co-creation effectively, constitute new vital models of sustainable *work-life* practices to assist people in this 'new normal'. It is important to have extensive understanding of those components (technological, social, epistemic) that work well, those that don't, and those to prepare for, in specific types of communities, these being defined by a specific *structure/scale* (i.e. social human capital), *scope* (i.e. cross-organizational) and *purpose* (i.e. Design disciplinary context).

Furthermore, as *social distancing* becomes the new standard, issues of *trust* and *power* -as interrelated socio-affective factors– are likely to be intensified in virtual communities that have no opportunities for co-presence (Aljuwaiber, 2016; Booth & Kellogg, 2015; Nilsson, 2019). This provides clear directions to place emphasis on proactive behavior, and mitigate the potentially negative impact of these factors on learning. Relevant findings from this work warrant that such probabilities are factored into the design of CoPs, and are embedded in the practical *guidelines* offered in chapter 10, constituting them as highly appropriate for the current situation.

Finally, the guidelines model developed as part of this research, represents an effort to supplement and join other methods and schemes in their contribution towards students' professional development (PD) while in university. That said, it is also presently amongst the few PD options available, considering that work placements (internships) have declined significantly in the wake of the pandemic and will continue to do so for some time. As any other PD initiative, these aim to cultivate a pre-professional/professional learner identity through the exposure of novices to the professional practice, the inherent knowledge and competence, and the ‘paradigmatic trajectory’ of the ‘masters’, who are responsible for guiding the interns (S. Brown & Ashley, 2017; E. Wenger, 1998). Likewise, the cross-organizational CoP model represents a fundamental opportunity for the development of learners’ pre-professional/professional identities (Jackson, 2016), through their co-participation and exposure to multiple levels of expertise within the same practice, lessening in this way the relational gap between academic and work-based experiences and lives.

1.6 Dissertation Structure

Following of the *Introduction*, this dissertation is organized in eleven chapters:

- Chapter 2: *Conceptual framework*. This chapter informs the reader about fundamental theories and concepts which underpin this research, in terms of its design, enactment, understanding, interpretation, and prediction-making processes. It provides extensive accounts of CoP and Creativity-related theories, offers a broad examination of the empirical work located in these, explains the analytical tools which frame similar investigations, and discusses the knowledge gaps that emerge through this process. The chapter serves as a critical knowledge base, so that the reader can comprehend the research design which follows in the methodology chapter.
- Chapter 3: *Methodology*. This chapter introduces the reader to the rationale behind the methodological judgments made for addressing the research objectives, makes an in-depth description of the methodological design that was employed, and provides a thorough justification of the research’s trustworthiness, based on quantitative and qualitative criteria. This chapter serves as the basis for understanding the methodological design of the six studies that comprise this research, which are reported from chapters 4 to 9.
- Chapter 4: *Study 1 – Technology Set*. Following the ACAD framework, this chapter describes the first study of the *Design & Implementation* phase (phase 1, semester 1), which explores the *technology configuration* design that supports

the cross-organizational CoP practice, and reports on the type and level of adoption by learners who participate in the CoP. As the ACAD components are known to be entangled on a practical level, this study was run concurrently to the other two, namely the investigation of the *epistemic* and the *social* components, which follow in the next two chapters. The sum of all three aim to address the first overarching aim of this research (see section 1.2).

- Chapter 5: *Study 2 - Epistemic component*. This chapter explains the second study of phase 1, which focuses on the *epistemic* design that guides the classroom and CoP-based learning practices. It examines the impact of CoP participation on the learners' epistemic cognition and creative outcomes, through comparisons between two groups of learners, and makes qualitative discussions to help explain the experiential aspects of CoP-based learning, with a particular focus on the two aforementioned variables.
- Chapter 6: *Study 3 – Social component*. This chapter involves the third study of phase 1, which investigates the learners' perceptions of their teams' *creative collaboration*, the type of *feedback* (as a critical component of Design collaboration) that emerges in CoP-wide interactions, how this relates to, or influences the *creative outcomes*, and the learners' related self-reported experiences. In order to measure perceptions of creative collaboration, this study employed the ASCC instrument (see 3.2.9.5), following its validation through study 4, which follows next.
- Chapter 7: *Study 4 – The ASCC*. This chapter describes the fourth study of phase 1, which reports on the validation of the psychometric properties of the Assessment Scale for Creative Collaboration (ASCC), which measures teams' perceptions of their creative collaboration in CSCL/CSCW contexts. The study marks the conclusion of phase 1, and provides the reader with the necessary evidence for comprehending the objectives and outcomes of study 5, in phase 2.
- Chapter 8: *Study 5 – Value Creation and learner identities*. Following phase 1, the fifth study constitutes the main body of work under phase 2 – *Evaluation*. Specifically, it draws upon the sum of findings from phase 1, and integrates these with new information collected in the second phase of the research. This blended dataset is then analyzed using the Value Creation (VC) framework, to evaluate the *worth* of *learning*, and derive inferences regarding the

transformation of *learner identities* through their CoP membership. This study is critical for introducing the reader to phase 3 and study 6, which is guided by the objective to extract design implications for cross-organizational CoPs in HE.

- Chapter 9: *Study 6 – Design implications*. This chapter describes the sixth study of phase 3 – *Integration* – which identifies both the effective and challenging findings of the CoP's design and enactment, and integrates these into a structured set of practical *design guidelines*. Lastly, to help simplify their transfer into other learning environments, the chapter concludes by offering examples of practical interventions, methods of evaluation, and appropriate technological tools to supplement each guideline, by referencing an extended version of the cross-organizational CoP model, in Appendix I. This addresses the second overarching aim of the research (see section 1.2), that is, to deliver practical governance mechanisms that are appropriate for specific types of CoPs in HE.
- Chapter 10: *Discussion*. This chapter summarizes findings from all the studies comprising this research, by addressing their initial research objectives. By placing emphasis on the second overarching research aim, it provides a critical discussion of the themes and guidelines propositioned in chapter 9, by drawing associations or distinctions between them and foundational CoP and adjacent theories. It also describes this work's contributions to CoP and Creativity research, and discusses its limitations and propositions for future work.
- Chapter 11: *Conclusion*. This chapter briefly summarizes the design and outcomes of this research.

2 Conceptual framework

2.1 Introduction

This chapter aims to underpin the *objectives* of the research (see 1.2) by locating them within related theoretical perspectives and empirical evidence, to guide the understanding, interpretation and prediction-making processes of its investigation. We have approached these objectives principally through the lens of *Communities of Practice* (CoPs), as well as *creativity and collaboration,* with *technology* playing a fundamental part in all of these. Specifically, while CoPs represent the primary theory that frames the design, enactment and analysis of this research, *collaboration* and *creativity* alongside *real-world vocational relevance* and the *transformation* of learner *identity* (the latter being subsumed in CoP theory) constitute its target outcomes and address the research questions in this work (see section 1.3).

This chapter is divided in six parts, as follows:

- It commences by drawing upon various sources to inform the reader about fundamental theories and concepts which relate to the design and analysis of CoP-based learning. Specifically, section 2.2, makes an introduction to *situated learning* and *legitimate peripheral participation* as the foundational theoretical concepts of CoPs. It then explains Problem-Based-Learning (PBL), an experience-oriented model which was employed as an instructional approach in the classroom, in this research intervention. The following three sections (2.2.4, 2.2.5, 2.2.6), *epistemic*, *socio-affective* and *technological* aspects of learning, constitute the three main components of learning under investigation in this research. Respective sub-concepts (i.e. *self-beliefs*, *interactions* and *feedback*) are presented to theoretically locate the phenomena that emerged in the studies which comprise this work.
- The second and third parts (sections 2.3 and 2.4) of this chapter provide extensive accounts of CoP and Creativity theory respectively, discussing their key sub-constructs, and importantly, their social/collaborative, and technological dimensions.
- The fourth part (section 2.5) concerns two frameworks that were employed to guide the analysis in this research. The first one takes a horizontal approach

(ACAD) to this research, attending to the technological, epistemic and social components of learning, and the second (VC) takes a vertical approach, providing a deeper understanding of the learning *value* created though CoPs.

- The fifth part, section 2.6 is dedicated a literature review of empirical work in the areas of CoPs and creativity, and considers various concepts that have developed from the latter's (creativity) association with disciplines that are inherently related to Design – such as HCI - over time.
- Finally, the chapter concludes with section 2.7, which discusses the gaps identified through the literature review and outlines the relevant research directions in the areas of CoPs and Creativity that surfaced as a result.

It should be mentioned, that we have framed the synthesis of these theoretical and empirical literature under the umbrella of a *conceptual framework*. This represents an integrated model which brings together concepts that reside across different theories, as well as a related literature review, to provide a broader understanding of the research problem and the predicted or emergent phenomena under investigation (Imenda, 2014).

2.2 Concepts of Social Learning and Instructional Approaches

In an effort to address the increasingly complex expectations for higher order thinking and 21st century aims, more recent perspectives of learning performed a step forward from the *cognitive* and *behavioral* theories, which had thus far respectively, either strongly focused on cognition (versus emotion), or did not place emphasis on the personal experience as influential for learning (Schunk, 2012).

Sharing a certain degree of similarity to the ideas of Dewey (as cited in Ann Boydston, 2008) and Piaget, Vygostvky's theory on social *constructivism*, radicalized learning by focusing on social symbolic interaction (language), stressing the role of both, the *inter-psychological* (individual, social environment) and *intra-psychological* (internal cognitive) dimensions for learning. Amongst others, Mattar (2018) discussed constructivism as an umbrella for various theories formed around the same time (past four decades), which addressed contemporary educational or instructional needs, placing emphasis on the *social* dimension, and prioritizing the *student-centered* and *humanistic* objectives for learning (J. M. de Oliveira et al., 2015).

Social cognitive theory (Bandura & Walters, 1977) played a fundamental part in this case, by challenging key principles of *behaviorism* and asserting that learning is the sum of a triadic reciprocal process between the *people* (cognitive), their *behavior* and the *environment.* This is considered as a conceptual origin for theories such as *cognitive apprenticeship* and *situated learning* (J. S. Brown et al., 1989a; Kearsley, 1994; Schunk, 2012). Bandura (1977, pp. 6–8) specifically identified that people learn by a) *observing* how others behave and creating models of these behaviors, b) encoding and *retaining* these models, through reinforcement (i.e. mental rehearsing), c) *motorically reproducing* and *practicing* these modelled behaviors, and d) using self and external influences for *motivation* and the *reinforcement* of new capabilities. The theory was extended to include *self-evaluative* dimensions (i.e. *self-efficacy*), as *self-regulatory* and *attainment* behaviors, such as effort, persistence, skills and performance (Pajares & Schunk, 2001). It has also served as a research framework across multiple fields in education and practice (Devi et al., 2017; S. K. Gibson, 2004; Harinie et al., 2017; Honicke & Broadbent, 2016; R. Wood & Bandura, 1989).

Succeeding theories of similar scope, stressed the centrality of *experience* and *reflection* in learning (D. A. Kolb, 1984; Rogers & Freiberg, 1994). Drawing from philosophical pragmatism, social psychology and cognitive developmental epistemology, *experiential learning* provided one such social learning theory (D. A. Kolb et al., 2001). Its four-stage model sees concrete experiences as forming through sensory input, generating observations and reflections (observed or self-experienced) which are converted into abstract conceptualizations. These in turn act as testing and experimentation guides in the formation of new experiences. Kolb et al. (2001) proceeded to link pairs of these four stages to specific learning styles (diverging, assimilating, converging, accommodating) in further work. Related empirical work supported the effectiveness of the theory (T.-C. Huang et al., 2016; Wurdinger & Allison, 2017), whose enactment has evidently facilitated higher-order thinking skills (Falloon, 2019; A. Y. Kolb & Kolb, 2009) and encouraged professional development for learners (Branch, 2015). Similarly, a representative study by Girvan et al. (2016) reported on the theory's beneficial impact on teachers' professional development, through motivation and subsequent reforms that employed more *student-centered*, *conversation-driven* and *interdisciplinary* approaches.

The technological advancements and the widespread of online learning, underpinned the rise of more contemporary theories, one of these being *connectivism*, as coined by Siemens (2005). This sees knowledge as a *social* and *distributed* phenomenon, and considers learning as transpiring *outside* the person (mediated, generated, manipulated and stored by technology), "based on rapidly altering foundations" (Siemens, 2005). The theory follows the notion of the *reality* of *chaos* as a 'cryptic form of order' and argues that *meaning* exists as a standalone property that requires people to recognize and find it by themselves, through connecting different nodes of information. *Connectivistic* pedagogy thus aims to construct and/or explain effective knowledge networks, through qualities such as *diversity, autonomy, openness,* and *connectivity* (Downes, 2008). However, related empirical work is relatively limited and largely focused on *distance learning* through MOOCs, which facilitate autonomous learning that transcends space, time and pace (Downes, 2020; Fondo & Konstantinidis, 2018; Hristova et al., 2018). Connectivism has been criticized based on *epistemological* and *psychological* concerns. Specifically, Clarà and Barberà (2014) noted that the theory under-conceptualized *interactivity* - despite this being a fundamental element in networked learning, as well as lacking extensive accounts of how *concepts* (as knowledge) develop, in the ways that these are supported in other theories (i.e. constructivism). Additional skepticism concerned MOOCs' limitation to enable active collaboration and teacher facilitation in learning. Castañeda & Selwyn (2018) further suggested that such theories with a primary emphasis on *digital learning* tend to be " little more than flat descriptions of the logistics of online information seeking and communication."

Following a brief review of related theories, and in line with the motivation and objectives of this research, we turn to a genre of social learning which perceives learning as inseparable from its socio-cultural and historical context; known as Situated Learning (J. S. Brown et al., 1989a; Lave & Wenger, 1991).

2.2.1 Situated Learning and Authenticity Approaches in Education

Situated Learning (SL) theory suggests that learning transpires through a transformative process of enculturation within a social and historical context (Farnsworth et al., 2016). This helps negotiate *meaning* and consequently develop new understandings on a given subject. Brown et al. (1989a) asserted that *meaning* is infused with qualities from the environment of its use, like for instance, learning words through talking, reading and communicating with others, versus through abstract definitions (i.e. that can be found in a dictionary). However the tendency of conventional pedagogy to separate *knowing (*knowledge) from *doing (environment)*, leads to *surface* knowledge and *slower* development, and does not reflect real-world scenarios. In this case, rather than drawing from a self-developed pool of diverse problem-solving capabilities, learners remain bounded to the specific patterns taught, which are often non-transferable to different settings (Collins et al., 1991).

In addressing these issues, researchers proposed SL as a new *learning paradigm* which aims to expose novices to the authentic complexities and uncertainties of the respective real-life domains (context), to unite the "what is learned" with "how it is learned and used" (J. S. Brown et al., 1989a) in order to create deeper and transferable knowledge skills (Herrington & Oliver, 2000; Stein, 1998).

Farnsworth et al. (2016) discussed a common misconception of situated (local) activities as merely bounded to the *physical* context. They clarified instead that *locality* refers to the authentic experience based on the relationship between the learner's identity and the *socio-cultural* context, allowing for richer understandings of the world (Greeno, 1998). In result, SL encompasses the 'learning by doing' approach, which encourages the learner's' active and social involvement in tasks, rather than the passive take-in of didactic material (Herrington et al., 2009).

Consequently, this generates logical challenges concerning the ways that education can *have access to* and *benefit* from such authentic situations in order to contextualize learning. Brown et al. (1989a) argued that transferred to the classroom, authentic activities are unavoidably influenced by the educational culture, and are therefore 'curated' and altered. Additional concerns suggested that the classroom environment is not suitable for SL activities since it lacks the *physical* context that allows apprentices to engage in interactions with 'masters' in a field (Tripp, 1993; Wineburg, 1989). That said, counter-arguments posit that although SL theory acknowledges the importance of *physicality* (Beaufort, 2000; Billett, 1994; Kavitha et al., 2015; Teunissen, 2015), it nevertheless sees the *enculturation* process as possibly commencing and enveloping as part of the safer, more familiar educational environments, prior to the actual transition into the workplace (Woolley & Jarvis, 2007). Relevant research provides ample evidence of the mediation of *authenticity* in the classroom through technology (Barab et al., 2000; S. Brown & Ashley, 2017). Coinciding with these views, Herrington et al. (2004) asserted once again, that *situated activities* can happen off-location; educators could instead shift their focus and efforts on ensuring that their instructional environments comprise the critical components required to situate understanding within a subject domain (i.e. through simulations). Technology in this case, acts as a 'surrogate', by mediating real-life settings "without sacrificing the authentic context", bypassing real-life distractions (Herrington & Oliver, 2000). Hoyle et al. (2013) confirmed the value of technology in situated practice in a workplace-based study, which described how geographically dispersed novice employees could leverage the value of intranet networks to connect with experts, for ongoing observation and mentoring purposes. Further, theorists (Herrington et al., 2009) informed technology-supported SL theory, by developing a framework to guide educators and practitioners in the design of online SL environments, comprising nine identifiable qualities, these being: authentic context, authentic activities, access to expert performances & process models, multiple roles & perspectives, collaboration, opportunities for reflection, opportunities for articulation, coaching & scaffolding, and authentic assessment.

Overall, two critical concepts emerged from SL theory in the foundational work of Collins et al. (1991) and Lave and Wenger (1991). Firstly, the concept of *situatedness* bore considerable relevance to the traditional models of *apprenticeship*, allowing novices to learn from experts (masters) through observation and guidance during work processes. Drawing on these, Collins et al. (1991) offered a framework to serve as an instructional paradigm for educators dealing with such complex learning tasks; the *cognitive apprenticeship* framework provided directions regarding the *content*, *methods*, *sequencing* and *sociology* of situated learning activities, and most importantly, it involved the presence of a social *community of practice*, that, as Lave and Wenger (1991) suggested, permits novices to observe and learn from various others – *rather than just a master* - at work.

Secondly, following on from that, Lave and Wenger (1991) drew attention to the role of such *situated observational experiences* in *learning*, even when novices were not full and active participants in the joint practice. They dubbed this phenomenon *legitimate peripheral participation*, that is explained in the following section.

2.2.2 Legitimate Peripheral Participation (LPP)

Drawing from historical forms of apprenticeship, 'Legitimate Peripheral Participation' (LPP) was explained as a form of learning that occurs through partial (peripheral) - rather than full - participation in a community (J. S. Brown et al., 1989b; Dennen & Burner, 2008; Fegan, 2017; Green et al., 2017). They postulated that this p*eripherality* does not equate 'disconnectness', but rather a legitimate *form of belonging*. It allows for the involvement and contribution of novices to evolve gradually, based on the *meaning-making* processes that transpire, while competences are increasingly developed and identities are gradually transformed in the community (Lave & Wenger, 1991; Moule, 2012; Woo, 2015).

Lave and Wenger (1991) discussed the propensity to visualize LPP as materializing in the outer peripheries of a circle with a single *core*, when in fact, the idea of *central* or *complete* participation, and a single *core* in a community is misleading. What LPP entails instead, is the possibility of assuming multiple positions and perspectives of participation that are not linear, and which change over time, based on the individual and community needs. In this aspect, heading toward more intensive forms of participation, constitutes *peripherality* a starting and an empowering point for movement along a trajectory that can transform the 'ways of knowing', competences and subsequently, identity over time (E. Wenger et al., 2002a).

Literature, carried various designations for such 'moving' participants among the various peripheries of the community (see Figure 5): newcomers, new-timers, beginners, novices and lurkers (A. Rourke & Mendelssohn, 2017; Tight, 2015; E. Wenger, 2010a). These work their way towards fuller participation by socializing and 'imitating' others, who are not necessarily masters, but more experienced peers, alumni mentors or upcoming experts in the field (i.e. real-world practitioners) (Eggleton et al., 2019; Panconesi & Guida, 2017). Evidently, this offers a powerful way to lower the barriers between academia and industry, allowing students to gain gradual relevance to the practices of their "future professional communities" in a domain (J. S. Brown et al., 1989b; Lombardi, 2007; Wonacott, 2000).

Other discussions on LPP posed that everyone's participation is in fact *peripheral*, given that even expert members still continue to learn from others through the new information that comes in, constituting the *core* of the practice (full participation) a moving target (Boylan, 2010).

2.2.3 Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is a constructivist instructional model, which places problems at the core of learning (Barrows, 1986; Savery, 2015). With its roots located in medical education, PBL has met extensive adoption in K12, higher education and professional development courses, and spanned across multiple disciplines and subjects (Barrows, 1996; Hmelo-Silver, 2004).

The model's philosophy draws a metaphor between its aims and a *springboard*, which is seen as initiating an effective spiraling process of *evaluation*, *proposition*, *research*, *conflict*, *argumentation*, *negotiation*, *application*, *resolution* and *reflection* (Boud & Feletti, 1997; Savery, 2015). These problem-oriented activities which occur collaboratively amongst team members, promote joint responsibility, coordination, management, and most importantly, knowledge-sharing (Hung et al., 2008). Team size and structure in PBL settings may vary depending on the breadth, perplexity and level of requirements of the assignments (Duch et al., 2001; Resta & Laferrière, 2007). Interestingly, research has evidenced that disciplinary, cultural or gender heterogeneity can augment teamwork within a PBL context, since it can improve awareness, acceptance and interaction with diverse views, experiences and learning styles (Barkley et al., 2014; D. W. Johnson et al., 2000).

The effectiveness of PBL has been largely documented in literature, with notable progress in *motivation*, *self-directed* and *active* learning, critical thinking, collective problem-solving and collaboration skills, as well as, increased student satisfaction (Choi et al., 2014; Colliver, 2000; Hung et al., 2008; Ioannou et al., 2016). Empirical research has indicated that certain PBL interactions, such as formal and informal group discussions, distribute leadership amongst team members, and regular interactions with facilitators, promoted *group motivation* and *creativity* (Zhou, 2012). Likewise, additional studies have reported on significant learner improvements, with particular respect to four key creativity dimensions, namely, *fluency, originality, flexibility,* and *elaboration* (Kuo et al., 2019).

PBL, as an experience-oriented model presupposes that the nature of problems is *ill-defined* and *messy* – yet – *authentic,* in reflecting the challenges of real-life open-ended discovery, which provides no explicit guidance for problem-solvers and invites the examination of several potential resolutions (De Graaf & Kolmos, 2003; Dewey, 1922). Aligning with the objectives of this study, PBL can evidently mediate *authenticity* in learning, through the adoption of simulation models (Ioannou et al., 2009) that enable learners to "practice the kinds of activities that they will encounter outside of schools" (Barab et al., 2000). For example, in an effort to mediate *authenticity* in paramedic and health care management education, Beaumont et al. (2014) used Second Life (a virtual 3D environment), using the affordances of the realistic immersive environment, to engage students in scenarios that are likely to be encountered in real life (i.e. accidents in public/private spaces, disease outbreaks). Their project involved end-users to design, test and evaluate the PBL scenarios for the teams of learners who would work on these. In this case *authenticity* was achieved through these 'messy' scenarios, allowing learners to consider various possible directions, just like in real life settings.

From a different perspective, Oliveira and Santos (2018), used a custom-built LMS called PBL-Maestro, which was specifically designed to integrate the methodological workflow (cycles/stages) of PBL in a computer networking course. The research motivation was rooted in the need to work with authentic variables, such as real-life *constraints,* budgets, lack of resources and client requirements, that shape the project-development cycle. The environment was designed to facilitate the resolution of such problems and to provide *authentic assessment* from clients who could monitor and evaluate the work-in-progress. Findings reported the positive role of PBL-enabled knowledge in the project cycle. Additionally the PBL-driven technology was found to enhance student *interest* and *motivation* in the subject, encouraged learners to dedicate time and effort to do 'their best' and supported the management of team conflicts.

We posit that based on the above, the resolution of real-life, *ill-structured problems* through *authentic collaborative* practices, lie at the intersection of *PBL* instruction and a *situated* approach to learning.

2.2.4 Epistemic Aspects of Social Learning

Amongst other objectives, this research investigates the effects of a socially situated learning intervention on the *epistemic* outcomes of learners. In doing so, it draws upon associated theoretical concepts, to better understand, support and frame the analysis of its *epistemic* investigation (Farnsworth et al., 2016; Murphy et al., 2007; Sandoval et al., 2016).

A concept relating to the above is *epistemic cognition*, a construct that evolved through several adjustments in terms of definition and scope. Murphy et al. (2007) initially offered the term *epistemological beliefs*, also known as *personal epistemology*, which refers to people's beliefs about the study of "knowledge and knowing" (Hofer, 2001), and the investigation of those beliefs from a research-oriented perspective (epistemology) (Greene & Yu, 2016; Murphy et al., 2012). The concept was later expanded and dubbed *epistemic beliefs*, to cover both a) the *researchers' beliefs* with a focus on the *study* of knowledge and knowing and b) the *students*' *beliefs*, with a focus on their own knowledge and knowing. However it still lacked the *procedure* through which *knowledge* and *knowing* ensue. The need for more inclusiveness in the definition, led to the term *epistemic cognition*. This refers to the learners' *knowledge*, the *justification* of *what constitutes* knowledge, *how knowledge is created* and *how it can be used* (Greene & Yu, 2016; Sandoval et al., 2016). Following the notion that all *cognitive* activity in learning occurs in everyday life and is highly *situated*, *epistemic cognition* is also embedded within a given *context* (J. S. Brown et al., 1989a). This may be the *tools* used, the *people* involved, the *interactions* taking place, or the *physical/digital environment* that hosts all of the above.

2.2.5 Socio-Affective Aspects of Social Learning

Literature draws connections between learners' *self-beliefs* (self-concept, self-efficacy), *motivational* factors (task-value, goal orientation), and *affective* aspects of learning, to guide the understanding of learning phenomena (Ames, 1992; Hounsell et al., 2008; Irvine, 2018; Lavasani et al., 2010; Värlander, 2008). According to Dillenbourg et al. (2009), the *affective* and *motivational* dimensions which critically impact collaborative learning, have been largely neglected by CSCL research. Additionally, given their strong interaction with *feedback* and *assessment* in learning, as well as their significance for the objectives of this research, we proceed to outline their theoretical and empirical associations. Specifically, research on *self-beliefs, motivation, social learning* and *feedback* is discussed in the following sections.

2.2.5.1 Self-beliefs and Motivation in Social Learning

Self-beliefs and *motivation* are presented as strongly associated in literature. Their understanding can help support and guide researchers' understanding of shared learning phenomena towards unpacking meaningful findings and forming beneficial pedagogical propositions (Ames, 1992; Bandura, 1991; Irvine, 2018).

A relevant theory on *goal orientation* (achievement motivation), investigates the 'why' and 'how' learners shape their achievement orientations (Dweek, 1986; Elliot & Harackiewicz, 1996). It comprises four main components: a) *mastery orientation*, referring to a learner's motivation to gain competence and to master a subject of interest, b) *performance orientation*, referring to a learner's aim to receive acknowledgments of competence from others (Kaplan & Maehr, 2007; Schunk, 1991). Likewise, c) *mastery avoidance*, referring to a learner's avoidance of errors and mistakes out of intrinsic interest in a subject and d) *performance avoidance*, referring to a learner's avoidance of potentially compromised performances, in order to avoid humiliation (Elliot, 1999).

Two types of self-beliefs, *self-efficacy* and *self-concept*, are closely related to *achievement motivation* in learning contexts (Bandura et al., 1999; C. W. Wang & Neihart, 2015). While researchers often use these interchangeably, Pajares and Schunk (2001) emphasized that they have distinct differences. While *self-efficacy* involves self-beliefs about one's capabilities, *self-concept* focuses on one's self-appraisal of one's worth; the latter tends to be particularly influenced by the social context (i.e. reflecting other people's beliefs). *Self-efficacy*, has also been positively linked to learners' *mastery goals* and negatively linked to *performance-avoidance* goals in relevant studies (Geitz et al., 2016; Honicke & Broadbent, 2016; Lavasani et al., 2010).

From a creativity point of view, Tierney and Farmer (2002) provided the term *creative self-efficacy*, to describe how individual or collective self-beliefs of creative potential can impact motivation, and the subsequent quality of outcomes. Chong and Ma (2010) clarified that *creative self-efficacy* can also be strongly shaped by the 'environmental' conditions and experiences, which gradually propagate onto the end-results. Within the same scope, Bandura (2000) referred to the term 'shared beliefs' and re-conceptualized *self-efficacy* to encompass the *social* perspective, as the '*perceived collective efficacy'*, which "fosters groups' motivational commitment to their missions, resilience to adversity, and performance accomplishments".

2.2.5.2 Socio-Affective Interactions in Social Learning

According to Kwon (2014) socio-affective interactions are emotional externalizations within a social context (i.e. relationships, expression, familiarity, trust, conflict, accountability) that bear critical effects on learning. For instance, studies suggest that people may resist *teamwork*, due to a lack of *connectedness* between them, or due to the limited – versus full – attribution, acknowledgement and ownership of the collectively-produced outcomes (Caspi & Blau, 2011). Additionally, feelings of vulnerability, driven by the fear of exposing epistemic and other weaknesses, are also heightened, during teamwork and collaborative learning processes (Waycott et al., 2017).

Likewise, the knowledge-sharing processes in social learning are also strongly influenced by *trust* (inter and intra personal) or *conflict* in teams - especially remote ones (Nilsson, 2019; W.-T. Wang et al., 2019). A *competitive* tendency (a trust-related symptom) between learners and co-workers can hamper engagement in team collaboration, and is bound to have stronger impact in online - as opposed to blended - communities (Amin & Roberts, 2008; Nilsson, 2019). Likewise, individual accountability may not be encouraged in online communities, as it can be easily bypassed or concealed based on the technology which facilitates the community (i.e. in asynchronous communication). Furthermore, if the technology involved is perceived as unsuitable, unusable, or overwhelming for users, it can produce feelings of *isolation*, *individualism* and *tension*, rather than *social collegiality* (Stone et al., 2017). That said, tension in teams is not always a bad outcome. On the contrary, it denotes deeper engagement in the work and can evidently ignite new ideas, invite more exploratory activity (Marcandella & Guèye, 2018) and promote further investigation in an aim to support the individual ideas and propositions (Kwon et al., 2014).

2.2.5.3 Feedback and Affect in Social Learning

Feedback is a primary component of social learning (Cummings et al., 2016; Popescu, 2014). It is also strongly associated with the epistemic processes in the Design and related areas (engineering, HCI, technology, architecture) where stakeholder participation - like user-testing, expert reviews, evaluations, and studio critiquing - are fundamental feedback elements in the design cycle (Adams et al., 2016; Huet et al., 2007; Østergaard et al., 2018).

Studies have evidenced both the positive and negative effects of feedback on learner self-beliefs and subsequent performances (Boud & Falchikov, 2006; Harks et al., 2014; Knight, 2002; Schartel, 2012). Its role as part of a formative, and an interventional aid to assessment, is critical as it can offer timely guidance, promote reflection and metacognition, and thus lead to higher epistemic accomplishments (Glăveanu, 2014, p. 88; Miller, 2009; Yorke, 2003). It has also been found to promote divergent thinking and generative processing (i.e. ideas leading to new insights) and thus foster the creative processes and outcomes (Hoever et al., 2018).

Feedback can also trigger undesirable effects in learning, specifically when it is predominantly negative or expressed in harsh tones. For instance, a study on written feedback in a cross-disciplinary (Business/ Design) educational context deduced that negative comments were deeply discouraging for students (Weaver, 2006). Likewise, other work posited that competitive feedback (i.e. comparing peers' scores) in quantitative forms (automated/scoring-based), not only triggered negative affect but also hindered the learners' self-perceived epistemic aptitude (Bower, 2005; Tekian et al., 2017). This approach reportedly made students less likely to persist in working with challenging tasks to master the problem at hand. Along the same lines, Biesinger and Krippen (2010) uncovered consistent declining effects on the self-reported *mastery* and *performance* sub-scales (goal orientation theory), for students participating in different conditions involving such automated forms of feedback.

The ramifications of harsh or competitive feedback on learners' *self-beliefs* and *motivation* are well documented in literature (Hyland & Hyland, 2001; Irvine, 2018; Jonsson, 2013; Price et al., 2010). This is an anticipated phenomenon, since evaluators tend to typically overelaborate on the 'negatives', while "scratching the surface" (Värlander, 2008) on the 'positives'. This held also true in studies employing less competitive approaches to evaluation and feedback. A study by Gormally et al. (2009), for example, involved *inquiry* (experimental) versus *traditional* learning and instruction (control) groups in a HE setting. Inquiry-based learning involves ill-structured, real-life problems, which students use to formulate principles, while justifying these with related evidence from theoretical and empirical sources, and undergoing questioning and critical reviews by the instructor and peers (Schunk, 2012). The study inferred higher gains in content literacy and research skills, but decreased levels of *self-confidence* for students in the experimental condition. This paradox lies in the differences between the safer and carefully monitored traditional environments (control group), and the challenging ill-structured problems, autonomy, and rigorous criticism which are inherent in the inquiry-based learning conditions. Interestingly, while these hindered students' *self-beliefs*, they still resulted in overall greater epistemic outcomes in the end (Gehlbach et al., 2008).

Like inquiry-based learning, *situated* and authentic learning approaches to feedback are prominent in related literature (Boud & Falchikov, 2006; Harrison et al., 2015). Boud and Falchikov (2006) suggested that such contextualized and constructive feedback can be effectively achieved through learning *communities* which invite the participation of external (i.e. industry) members. Specifically, they argued that this can help students develop aptitude in judging their own outcomes, drawing from external and professional perspectives and benchmarks, as opposed to solely academic ones (Gilbuena et al., 2015; Rodgers et al., 2014). For example, communities that comprise students from other institutions, prospective audiences, industry experts, clients, prospective employers or government representatives, can offer the much-needed diversity of *feedback* in social learning. Students can then use this to build real-world relevance and professional competence, prior to their industry transition (Albats, 2018; Etzkowitz & Ranga, 2015; Price, 2005).

2.2.6 Technological Aspects of Social Learning

Digital literacy and ICT skills are not merely important for practicing routine activities such as accessing the internet and using systems and software effectively. They are especially crucial in learning, due to technology's potential to support further exploration, organization, evaluation and creation of new knowledge, as well as the communication of digital information and the development of effective collaborations, to cultivate strong and sustained life-long learning skills (Binkley et al., 2012).

Technology in education has the irrefutable potential to facilitate the growth of several sought-after 21st-century skills (WEF, 2016). As empirically reported, technology has over the past years involved a wide collection of tools, comprising integrated productivity and communication environments (i.e. document-editing and management, email, chat, video, blogs, discussion forums) (Liu & Lan, 2016; Martin & Tapp, 2019), e-learning management systems (LMS) (F. S. de Oliveira & Santos, 2018; Horvat et al., 2015; Kabassi et al., 2016), dedicated experimentation and integrated development environments (IDEs) (Mavri et al., 2019a; Morgan et al., 2014; Popescu, 2014), community platforms (Galyardt et al., 2009), collaborative online games (Przybylek & Kowalski, 2018), social media networks (Kivunja, 2015; Novakovich et al., 2017), virtual reality environments (Beaumont et al., 2014) and augmented reality applications (Martín-Gutiérrez et al., 2015) .

Aside of digital literacy, the assimilation of online technology in classroom practices, has a primary impact in the development of key 21st century skills, such as *collaboration*, *communication* and *creativity*, which constitute the research variables in this work. Modern pedagogical approaches (i.e. inquiry-based, situated, connectivist learning) which have come to rely on the systematic integration of informal learning tools in the curriculum, require that students engage in critical discourse, information sharing and collaborative learning and work processes (Kivunja, 2015). A study by Al-Rahmi et al. (2015) stated that problem-solving discussions on social media, between research students, peers and supervisors had significant positive impact on the students' overall *communication* and *collaboration* skills. Likewise, Al-Zahrani's (2015) study inferred that using online (video) lectures, combined with in-class discussions, problem-solving and feedback activities, as part of a flipped-classroom approach, led to significantly higher *creativity* scores, in terms of the *fluency*, *flexibility*, and *novelty* dimensions. The study also mentioned that the use of technology, allowing for independent and autonomous learning, was a likely cause for the development of students' creative thinking skills. Focusing on the same area, Daws and Wegerif (2004) posited that in an educational context, *creativity* can be encouraged based on two factors; primarily, a comfortable and safe social setting for collective experimentation, and a technologically sound ICT environment, that is capable of supporting this.

Another point of interest is the important part of technology in the intersection of PBL and situated learning for infusing learning with *authenticity*. Its role as a window to the outside world is critical, providing access to the actual practices of a domain, expanding feedback and assessment beyond the faculty, and proactively introducing students into their future professional practice (Bhatnagar & Badke-Schaub, 2017; P. Brown, 2015; Herrington et al., 2014; Jackson, 2016; Loizides et al., 2019). This perspective is important, due to the increasing interest in supporting university-industry (cross-organizational) collaborations to enhance learning and prepare young graduates for their industry transitions (Iskanius & Pohjola, 2016; Mulgan et al., 2016).

That said, studies investigating the use of ICT in education with a particular focus on cross-organizational collaborations are still scarce (WEF, 2015). Potential causes lie in the multi-faceted nature of educational technology, which needs to take into account variables such as the cross-organizational social configuration, the complexity of requirements, the intra/inter-team dynamics, different learning and work styles, and socio-affective factors (level of *trust* in the relationships that transpire) (Biggs, 1985; S. W.-Y. Lee & Tsai, 2011). Moreover, the external (industry) parameter adds considerable complexity to the investigation of ICT in these collaborations, due to the multi-level heterogeneity of their stakeholders' technology characteristics, needs and limitations.

2.3 Communities of Practice

Drawing from social learning paradigms and grounded in situated learning (SL) and cognitive apprenticeship theories (J. S. Brown et al., 1989a; Herrington & Oliver, 2000; C. M. Johnson, 2005; Lave & Wenger, 1991), CoPs is a social theory of learning, that refers to groups of people who share common interest and goals in a field and connect to collectively create knowledge and competence. According to Wenger (1998) who coined the term, learning occurs informally, just by living and interacting in the world, and involves participation in various communities which provide members with different opportunities for learning.

The term ‘practice’ in the CoP context represents the social processes and routines developed by members, that allow them to attain their collective goals more effectively and satisfactorily. Practice in this sense, is not regarded as the sum of thoughtless, mechanical actions; it rather embodies both the *theoretical* and *practical,* and the *mental* and *mechanical,* in ways that members engage in learning experiences guided by a collective *enterprise* (E. Wenger, 1998, 2010a; E. C. Wenger & Snyder, 2000). Thus the CoP perspective conceptualizes practice as comprising *knowing, reflecting* and *acting* entrenched within, rather than disembodied from one another (E. Wenger, 1998). This aligns with a fundamental conception in Schön’s (1984) earlier work - ‘reflection in action’ - which postulates that in day-to-day practice, professionals go through several “tacit recognitions, judgments, and skillful performances”, which encompass concurrent *reflection* and *performance* activities.

The activities in a CoP assume ‘meta-meanings’ that constantly evolve in the practice and generate new meaning-making experiences. Barab and Duffy (2000) state that *meaning* can only be defined within a social context, where the amalgamation of historical (past) patterns and new stimuli can alter, restructure, augment, re-interpret, reject or validate it accordingly. This process is understood as the ‘negotiation of meaning’ in CoP contexts (E. Wenger, 1998, 2010a; E. Wenger et al., 2009).

The foundational CoP theory (E. Wenger, 1998) proposes two key meaning-negotiation processes in the community, namely *participation* and *reification*. These are considered as an inter-influencing duality, making learning feasible only through a functional balance of the two.

2.3.1 Participation

Participation involves both acting and connecting, but is also an act of recognition, in that people recognize their own meaning interpretations in others’ views and decide to connect with them (A. J. Rourke & Coleman, 2009; A. Rourke & Mendelssohn, 2017; E. Wenger, 1998, p. 55). It is a legitimate, dynamic and multi-faceted process of relating to and interacting with others, thinking and perceiving, and affecting and being affected, guided by a sense of inclusion and belonging.

The degree of participation is not necessarily equal or balanced (E. Wenger, 1998). In fact, the disparity in knowledge and competence, is what drives the meaning-negotiation processes and facilitates learning in CoPs. According to Roberts (2006), participation is interconnected with power, as fully participating members are “likely to wield more power in the negotiation of meaning”. Further, participation is also an integral element of *identity*, as it transforms how people act, and how they (and others) perceive themselves and their actions in the community. It therefore helps generate understandings of the unique *identities* of people, as these emerge in the community (Farnsworth et al., 2016; Lave, 1991; Nistor & Fischer, 2012).

A CoP’s practice is commonly enacted across three levels of participation: a) the *core* group, typically the leadership of the CoP, with members who engage in vigorous contributions, partake in projects and help steer the community, b) the *active* group, a level down from the first group, with members who are active in public discussions or meetings, but still remain outside the core group, and last c) the *peripheral* group, with members who seldom interact or contribute to the community; yet, as observers, they might engage in private discussions, absorb information, “gain their own insights” (E. Wenger, 2001) and apply them in their own time. A more recent and detailed version of the model (see Figure 5) added two more levels, namely the *occasional* (members participate only when something is of interest or when working on specific projects), and the *transactional* (outsiders who interact in a few exceptional cases to provide or access a service or product). However, these levels may or may not necessarily exist in a community (Wenger-Trayner, 2011).

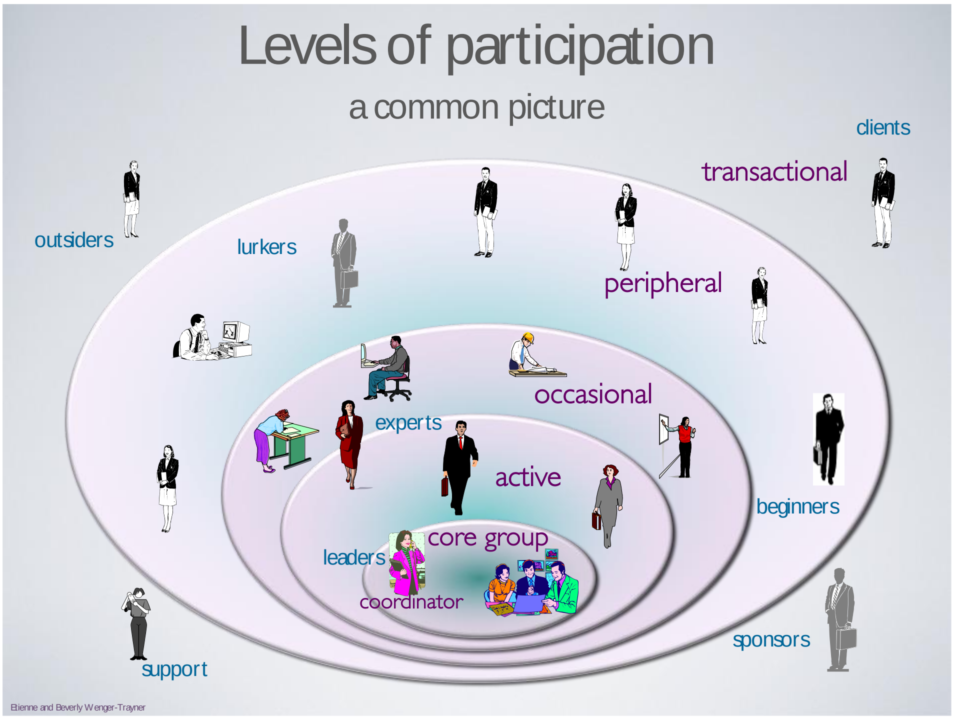


Figure 5: Typical categories of membership and participation in CoPs (Wenger-Trayner, 2011)

2.3.2 Reification

The second *meaning-negotiation* process involves the transformation of intangible elements (i.e. concepts or mental processes) into more concrete pieces of reference, what is described as 'reification' in CoP terms (Agrifoglio, 2015; Barab & Duffy, 2000; A. DeChambeau, 2017).

This may involve both the acts of *abstraction* and *specification* of concepts that members develop and project onto their community, for the purposes of sharing conceptual artifacts (i.e. identity: man/woman, status: expert/beginner, characterizations: naïve/well-informed), as well as *actual artifacts* (i.e. files, indexes, rules, manuals, resources). These can support the practice, serving as "shortcuts for communication" (E. Wenger, 1998), and enhancing rhythm and efficiency. In his interview series with Farnsworth et al. (2016), Wenger emphasized that while reified elements are important for providing clues as to the *identities* of members in a CoP, they only gain their *meanings* as they become *experienced*, *accepted*, *rejected* or *verified* through *participation*. This justifies how the two, *participation* and *reification*, are inextricably bound, in enabling effective social learning in CoPs.

2.3.3 Dualities

Wenger (1998) stressed that the design of CoP-based learning can be challenging, since it is bound to encounter issues related to *meaning*, *time*, *space* and *power* (Wenger, 1998). The CoP theory explains these issues as a set of dualities*;* they represent pairs of opposites, which – like participation and reification - are inseparable and complimentary to one another. Designing for learning through CoPs should not prioritize one over the other, but instead aim to 'combine them productively' in a balanced manner.

Aside of *participation* and *reification* **(**described above), other dualities refer to the *designed/emergent*, the *local/global* and the *identification/negotiability* dimensions (see Figure 6).

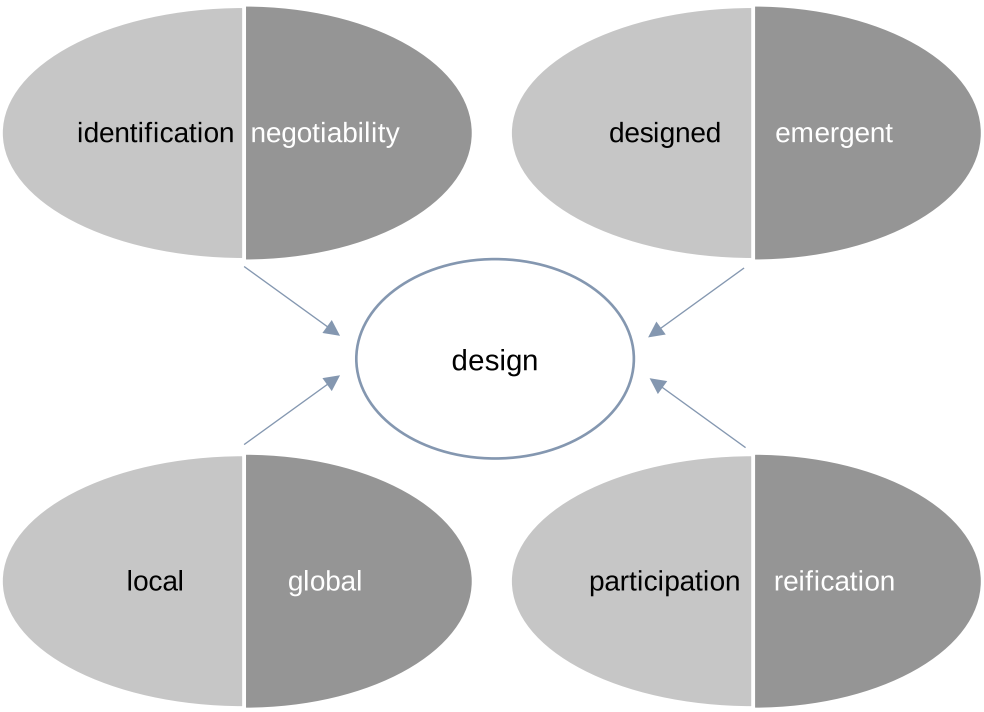


Figure 6: Four dualities as dimensions of design for learning in Cops

Probst and Borzillo (2008) reviewed how CoPs had traditionally emerged as spontaneous and self-initiated entities. That said, a substantial body of research has provided evidence on designed and/or managed CoPs, which aim to leverage their potential as learning networks, typically transpiring in organizational or professional-development contexts (Aljuwaiber, 2016; Borzillo, 2017; Forsten-Astikainen et al., 2017; Pyrko et al., 2017; E. C. Wenger & Snyder, 2000). In this case, the authors posited that while *CoP administrators* play an important role, they cannot "fully own or control" the community or its practice. This represents the second important duality of learning in CoPs, namely the duality of *designed/ emergent*. Wenger (1998) affirms that communities cannot design their own practice, in other words, "practice cannot be the result of design, but instead constitutes a response to design". This view is also supported in other learning-oriented theories (Carvalho & Goodyear, 2014a) suggesting that collaborative learning activities cannot be predicted - but rather anticipated – depending on their enactment by participants within a given context.

The third duality, *local*/*global* reflects the different *levels* of participation, referring to the *locality* of engagement in a CoP, as well as the expanded broader context of a 'constellation' of (global) communities (Contu, 2014; E. Wenger, 1998). These two are not exclusive but rather supplement and inform each other.

The fourth and last duality, *identification/negotiability*, refers to the process through which concepts are understood as representative of one's (or group's) identity, like a category, role, attribute or relationship for instance (identification). *Negotiability* reflects the power to control and shape the meaning of these concepts in the community (Lees & Meyer, 2011; U. Smith et al., 2017).

2.3.4 Constituents of Coherence in CoP practice

There is abundance of CoP-based research analyzing, discussing and verifying the foundational theory, through the lens of the three constituents of a community's practice (Cheng & Lee, 2014; A. DeChambeau, 2017; Evans et al., 2014; Johnston, 2016; Patahuddin & Logan, 2015; Pyrko et al., 2017; Schmitz Weiss & Domingo, 2010). According to Wenger (1998), CoPs presuppose a *joint enterprise*, *mutual engagement* and a *shared repertoire* (see Figure 7), which set the foundations of coherence in a community.

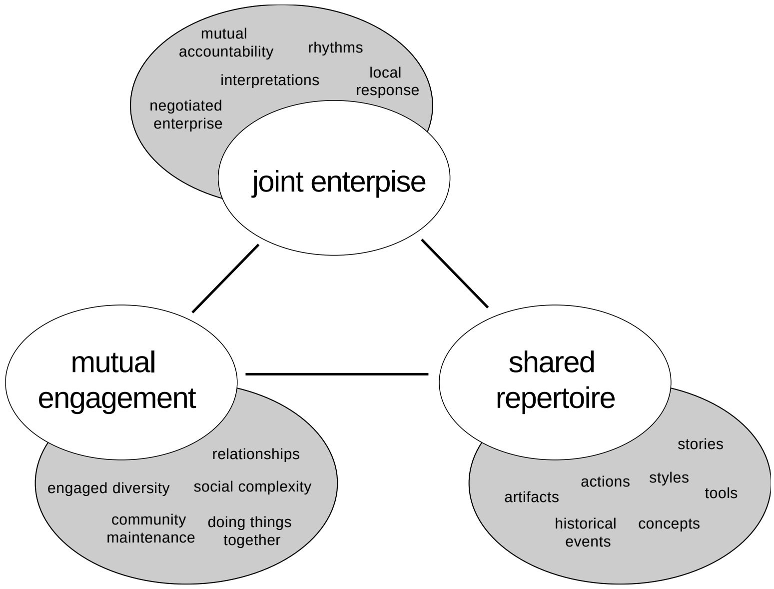


Figure 7: Constituents of coherence in CoP practice (Wenger, 1998)

Mutual engagement refers to the active involvement and collective negotiation of meaning that holds members of a community together, beyond the mere existence of personal or social similarities (Vangrieken et al., 2017). *Engagement* is a term often used interchangeably with *participation,* which is misleading for readers. Wenger (1998) explains that *participation* persists even in inactive conditions; in other words members do remain as *participants* of a community even if they don't *engage* in practice. Conversely, *engagement* denotes a member's active involvement to serve a shared enterprise, rather than just belonging (E. Wenger, 1998). Engagement involves a "kind of personal investment that makes for a vibrant community" (E. Wenger et al., 2002a) and commitment that cannot be forced. It is thus possible that members may become *engaged* in varying levels and intensities, at either steady or irregular rhythms and times, based on interest, choice and conditions in the practice (Power & Armstrong, 2017).

Diversity in knowledge and competence, is also key for efficient mutual engagement, as it supports multiple types of connections that dynamically form, change, and negotiate meaning (A. DeChambeau, 2017; E. C. Wenger & Snyder, 2000). In other words, each member makes unique distinguishable contributions to the community and engages differently, in different situations, and with different members (E. Wenger, 1998).

Joint enterprise, the second constituent of practice, refers to a *common purpose* that CoP members pursue, through *mutual engagement* and *accountability* towards its attainment (Cheng & Lee, 2014; Lave & Wenger, 1991). Wenger (1998) emphasizes that just like mutual engagement, *joint enterprise*, does not necessarily reflect total uniformity or full agreement. In fact, researchers like DeChambeau (2017) for instance, discuss *disagreement*, *tension* or *conflict*, as expressions of interest and commitment, that if carefully handled, can promote constructive relationships between CoP members (Fox, 2000a).

Shared repertoire, the third constituent of CoP practice, refers to the routines, processes, aids, symbols, gestures, vocabulary and styles that develop tacitly or explicitly over time in a community (Handley et al., 2006; Johnston, 2016; Roberts, 2006). These are built upon a history of social expression and interaction (in practice) and serve as resources for the fresh meaning negotiations that are attached to these experiences, and which accelerate practice and promote learning.

2.3.5 Modes of Belonging and Identity Formation in CoPs

As learning entails experiences that transform who people are and what they do, it is inherently linked to *identity* (Woods et al., 2016). Pratt and Back (2013) argued that identity in CoPs should *not* be merely understood as reflecting knowledge and skills (a cognitive perspective), but rather an ongoing process of becoming – a *trajectory*. Indeed, Wenger (1998) discussed identity as entrenched in the practice, constantly being reconfigured across the multiple negotiated experiences which occur both on a *local* (internal) and a global (external) level. It is both individual and social (how we, and others see us), and it evolves in three phases - known as modes of belonging - namely, *engagement*, *imagination* and *alignment*.

Engagement, as discussed reflects commitment to the meaning-negotiation processes, that shape the *history* of a certain practice (Farnsworth et al., 2016). This mode has a bounded character, in that is succumbs to boundaries of space and time. In other words, members in a CoP have, by default, a certain amount of hours to dedicate and activities to perform, a certain amount of artifacts to co-create, and a certain amount of people to connect with in a certain practice. In contrast, *imagination* can carry unlimited projections of ones' self across time and space, extrapolating from lived experiences; it is thus *boundless* (E. Wenger, 2010c). Through these projections, one can place oneself in a network of imagined realities and shape one's identity accordingly. As Morley (2016) asserts, "alignment and imagination, carefully woven with the experience of participation, can extend students' identities beyond the boundaries of immediate engagement". It is worth noting that these imaginative acts are *collective* rather than *individualistic*, as they are informed and molded by the social context of the practice.

Following *engagement* and *imagination*, *alignment* refers to the coordinated activities of CoP members to adjust and fit into a practice, or a broader set of practices. Wenger (2010b) considers this "a two-way process of coordinating perspectives, interpretations, actions, and contexts" as the members' *alignment* actions do not only have individual, but also collective dimensions and impact.

2.3.6 Global Participation in a Landscape of Practices

The foundational CoP theory discussed the *global* dimension of CoPs, since members participate (fully or peripherally) in various other communities which may have their *boundaries*, but are nonetheless inter-connected, since they service and support each other. Indeed, research in CoPs has supported the notion that "no community exists in isolation" (De Moor, 2015) and that the social *history* and *reified* items of CoP practice derive from both *local* and *global* activities, through *boundary encounters* and *objects* that are transported across practices, what is known as *brokering* (P. Brown, 2015; Cobb et al., 2018; Hefetz & Ben-Zvi, 2020). Theory suggested that in this way communities benefit from *multimembership*, by addressing characteristic *discontinuities* between practice (E. Wenger, 1998). An example of such, would be the knowledge, skills or services required for a specific purpose, which are not available in the local practice. Through brokering, such 'imported' *competence*, *styles*, *discourses*, *practices* and *objects* acquire local meanings in a community, forming in this way broader 'constellations and networks' that enable *continuity* (i.e. shared understandings) across different practices.

Wenger et al. (2014) later on reconceptualized the original theory toward this direction, to include the concept of a *Landscape of Practices* (LoPs). LoPs theorize that through participation, CoP members can understand the *geography of competences* that is relevant to their subject domain - what is known as '*knowledgeability'*. Using their *identity* as a filter, they can then locate and orient themselves within this geography (E. Wenger-Trayner, 2016), through continuous cycles of *identification* and *negotiability* (see section 2.3.3). In other words, members become aware of and identify (*identification*) with other practices and communities, and actively try to contribute to their meaning-making processes, hence negotiating a position within them (*negotiability*) (Farnsworth et al., 2016). Pyrko (2019) conceptualizes LoPs as "a wider landscape of *situated* curricula—that is, the regime of knowledgeability of other local practices which fall within the same landscape".

2.3.7 Delineating CoPs from other Social Groups

Wenger (1998, p. 122) warns about misinterpreting any 'social configuration' (a group of friends, a gang, a class, an operational team etc.) for a CoP, since this would undermine the philosophy behind it. Despite some common attributes, CoPs delineate themselves by attaching their efforts to a *domain* (area, subject, field of interest), forming a *community* (socially participating and learning together), and generating and sustaining a *practice* (engaging in and developing a collective repertoire) across time. Rooted in these, comes a sustained history of *mutual engagement*, meaning negotiation, and co-creation of *routines* and resources to help support the practice, in purpose of a *joint goal*.

Distinct characteristics can be found between CoPs and other social formations such as such as 'communities of interest' (CoIs) and informal networks. Specifically, CoPs are homogenous groups from a disciplinary perspective; that is, they are formed by memberships which originate from the same discipline and subscribe to a common knowledge system (i.e. Design); whereas CoIs are heterogenous, in that they involve multidisciplinary groups with different (epistemic) backgrounds and belong to multiple domains (and potentially multiple CoPs) to work on a "problem of common concern" (Fischer & Bell, 2004).

Probst and Borzillo (2008) also provide an all-rounded discussion on the distinctions between CoPs, project-teams and informal networks. Project-teams have clearly defined roles, responsibilities and measurement criteria, thereby forming a "task-driven partnership" (Farnsworth et al., 2016). On the contrary CoP members are not typically assigned with specific actions or measurable tasks, and their interactions and relationships are sustained beyond the completion of tasks or projects. In fact, Wenger (Farnsworth et al., 2016) stresses that CoPs can include members who work in different teams but still connect and learn together in the practice.

Informal networks (organization-based), as social formations, are also concerned with networking and sharing information on different topics, yet remain active for as long as the network serves their *business* relations and needs. On the contrary, CoPs are *learning partnerships* with a focus on a particular *domain* and extend the transitory nature of informal networks. Additionally, Wenger et al. (2011) noted that like communities, *networks* also involve social connections for knowledge-sharing purposes, but are mostly driven by individualistic rather than collective (identity-sharing) incentives.

2.3.8 Virtual CoPs

A decade after the introduction and extensive study of CoPs as a social learning theory, Wenger and associated researchers (E. Wenger et al., 2009) drew upon empirical investigations to derive a dedicated framework for virtual CoPs (VCoPs) (Hafeez et al., 2019). The framework defined the technology framework for CoPs as comprising four main components, namely *tools, features, platforms* and *configurations.* These are explained as*:* a) *tools*: software for specific purposes (i.e. email-client, vector-editor, word-processor) (Cherry & Latulipe, 2014); b) *platforms*: packages that combine various tools, as in the case of Google's G Suite (*G Suite: Collaboration & Productivity Apps for Business*, n.d.) or Microsoft's Office 365 cloud, used for generic productivity, communication and storage purposes, with shared access and functionality (Spagnoletti et al., 2015), c) *features*: specific user-interface properties (i.e. filtering, sorting, customizing), and d) *configuration*: the entire selection and arrangement of the above-mentioned elements. A course for instance, could employ a Learning Management System (LMS) (Clarke, 2009; J. Y. Park, 2015), supported by a social network (SN) (A. DeChambeau, 2017; Gunawardena et al., 2009), as well as domain-specific software, like a Creativity Support Tool (CST), to accommodate the specific epistemic needs of practice (Cherry & Latulipe, 2014). Within the context of this dissertation, CSTs refer to software for the development of creative artifacts like sketches, design prototypes and other visual and interactive artifacts.

The VCoP framework (E. Wenger et al., 2009) also proposed that CoP *stewards* (administrators, moderators) These *orientations* include meetings, open-ended conversations, projects, content, access to expertise, relationships, individual participation, community cultivation, and servicing a context. The framework adds that orientations are useful, only if they map to *field-specific* (i.e. architecture) epistemic activities. Only then can they translate into technical requirements for the CoP's technology configuration.

While fundamental for practice, technology configurations alone do not constitute a recipe for effective CoPs (U. Smith et al., 2017; E. Wenger et al., 2009). Their key purpose is to serve the unique requirements and characteristics of the *field of practice* and to support the specific *social infrastructure* ,which they are deployed for (U. Smith et al., 2017). Most importantly they should afford various modes of access and participation (i.e. semi-private, private, CoP, public) so as to enable fluent LPP for their members (Cundill et al., 2015; Gaillard & Rajic, 2014; Green et al., 2017).

Over the course of time, various studies indicated that typical technology configurations for CoPs employed learning-management-systems (J. Y. Park, 2015), social media and networking applications (i.e. Facebook, Twitter) (Komorowski et al., 2018; Miniaoui & Halaweh, 2011), general productivity and storage systems (Google Docs/Sheets) (Burns et al., 2016; Stone et al., 2017), blogging software (A. Rourke & Mendelssohn, 2017), creativity support tools (CSTs) (Cherry & Latulipe, 2014; Shneiderman, 2000), content management systems (CMS) (Steiner, 2017), and dedicated private or public community platforms (i.e. Stack Overflow) (Frith, 2014; Galyardt et al., 2009; Mamykina et al., 2011).

2.4 Creativity: Theoretical Perspectives

Creativity lies at the intersection of a multi-disciplinary set of backgrounds which come together with an aim to produce suitable, novel, user-centered and technologically advanced outcomes (L. Leung & Bentley, 2017). As a single *creativity* framework is absent from literature, this section provides a broad review of the various theories that surround the construct, since they are highly relevant to the objectives of this research.

Guildford's (1967) contribution to creativity research has been fundamental, based on the aim to provide a concrete definition for the construct (Batey, 2012; Kurtzberg &

Amabile, 2001; Shneiderman, 2000). By associating it to *divergent thinking,* he offered a model which defined *creativity* in its three main dimensions: *sensitivity to problems, fluency* (ideational, associational, expressional), and *flexibility* (spontaneous, adaptive). By perceiving creativity as a part of *intelligence*, the model sees every mental task as involving three components, an *operation*, a *product*, and a *content* (and their subsets), generating in this way a total of 120 possible combinations of creativity definitions (Sternberg & Grigorenko, 2001). The complex and multi-dimensional nature of the construct and the respective attempts to theorize and model it, has generated considerable discussion amongst researchers over the course of the past few decades (Allee, 2000; Hildreth & Kimble, 2004).

Creativity research has looked at many different dimensions, such as the cognitive abilities, personality traits and inclinations (Amabile & Pillemer, 2012; Barron & Harrington, 1981; Batey et al., 2010; Davidson & Sternberg, 1984; Kurtzberg & Amabile, 2001), the creative *process* (Mednick, 1962), the *social* context (Plucker & Makel, 2010), the *epistemic* domain (Furnham et al., 2011; Kaufman & Baer, 2005) and the outcomes or *products* (Horn & Salvendy, 2006; Lew et al., 2013; Zeng et al., 2009, 2012). However, the need for conceptual links between these dimensions was prominent in all related literature. An important assertion made by researchers was that creative *processes* and *outcomes* are strictly entwined, adding that process-related phenomena are worth exploring, only if they lead to creative outcomes; hence the investigation of the two should coincide (Amabile et al., 1996; Romeiro & Wood Jr, 2015).

In this context, Rhodes (1990) discussed creativity as subsuming four *entwined* perspectives - the four Ps – referring to the *personal traits* (Person), *process, product* and *press*. The *personal traits* concern the individual characteristics of people (i.e. introvert-extrovert, decisive, imaginative, patient), the *process* reflects the individual or team activities involved in the creation of artifacts, the *product* reflects the end-results, and the *press* reflects the environment within which these materialize. In this context, Amabile and Pillemer's (2012) work presented a new approach to apprehending the multidimensionality of creativity, through the 'Componential theory of Creativity', which identified two main psychological and social components, specifically the *intra-individual* and the *social*. The *intra-individual* consists of three sub-components: a) *domain-specific* knowledge, skills and tactics to be utilized in response to a problem, b) *creativity-specific personality* traits, i.e. divergent thinking, risk-taking, systematic approaches and perseverance and c) *task motivation*, referring to the innate interest in and attraction to challenge, that is not caused by extrinsic stimuli (i.e. a reward or punishment avoidance). The *social* component reflects the social conditions that people find themselves in during the creative process. These may foster (i.e. innovation encouragement, ideas sharing) or undermine (i.e. criticism, low-risk tendencies, political issues) creativity.

Following an exhaustive, large-scale review of twenty-first century *creativity* literature, Hennessey and Amabile (2010, p. 572) inferred that creativity research remained largely *fragmented*. One of the causes behind this, was the isolation of the multiple creativity dimensions and sub-fields under investigation, the respective socio-cultural attributes, theoretical stances, methodological approaches, and the different questions asked in each one (Glăveanu, 2014). They had however inferred that the research community reached consensus in a contemporary designation of creativity, which was explained as the aptitude of individuals *or* teams, the processes, and the environment that shapes these processes to generate products, that are both novel and useful for a purpose, according to social judgment. This established that the many aspects of creativity warranted a more *integrative* approach to their investigation (Amabile, 1982; Furnham et al., 2011; Kaufman & Baer, 2005; Mumford, 2003; Plucker et al., 2004; Runco & Okuda, 1988; Sternberg & Lubart, 1999).

2.4.1 Distributed Creativity

Researchers proposed that individual creative traits and processes become augmented, as they manifest collectively within a social context (Fischer, 2007; Gennari & Reddy, 2000; Sawyer & DeZutter, 2009; Scott, 2015). They suggested that individual expression, through interaction with others and the environment, generates an intertwined process of socially and culturally-grounded creative incidents, constituting creativity a “systemic rather than an individual phenomenon” (Csikszentmihalyi, 2013). Aggreging with this direction, Barab and Duffy (2000) defined *cognition* and *ability* as the sum of “talented transactions” between the individual and the environment, while following the same concept, Warr and O’Neill (2005) pointed that a collective form of creativity is bound to be, in principle, “more productive than individual creativity”.

Sawyer and DeZutter (2009) posited that creativity research should hence, primarily shift its focus from the *individualistic* to the *distributed*. A new point of interest thus involved exploring how creative artifacts ensue from *collective* – versus *individualistic* - effort, and drawing correlations between specific collaborative episodes and resulting artifacts of creative value (S. Harvey, 2014; Karakaya & Demirkan, 2015a; Sawyer, 2018; Uzzi & Spiro, 2005).

Paulus and Nijstad (2003) noted that while there was shared understanding on the importance of such contextual (socio-cultural and procedural) dimensions, literature still lacked a systematic approach for investigating how these come together under the lens of *creativity*. They thus proceeded to offer four themes as recommendations for the enablement of social or *distributed* creativity in groups, these being: a) encouraging group diversity (functional, informational, cognitive) - versus homogeneity – for innovative creation, b) lowering the risk of undermining group motivation and coordination, to augment the creative potential c) treating the group climate as critical (i.e. trustful, restrictive) for promoting or hindering divergent thinking and creative activity, and d) focusing on the interaction between group and environment (i.e. social, cultural, organizational), as crucial for creative development.

Along these lines, Glăveanu's (2014) later contribution to the theoretical expansion of *distributed* - creativity, was significant, through a dynamic conceptual framework, that saw creativity as emerging through the entanglement of *social*, *material* and *temporal* dimensions; three respective *lines of distribution* were thus offered. Briefly explained, the *social line* refers to *co-creation*, (directly transpiring through actual collaborations and indirectly, through previous intellectual contributions from others, or through the 'social marks' of the tools and resources used), and *social construction* (awareness of others' 'voices' that judge the value and accept/reject creative outcomes). The *material line*, takes into account the *agency* of objects and artifacts, and the overall affordances (i.e. intended ways of use) of the contextual environment in supporting or resisting creative processes. Finally, the *temporal line* which considers the role of *time*, from a cultural-historical perspective (i.e. past contributions), the individual trajectory perspective (evolution over the course of a creators' lifespan), and the micro-temporal perspective of 'creativity in the making', as in the run-time processes that allow for micro changes and adjustments that generate creative results.

In later work, Hennessey (2017) observed that over the past few years, research appears to be more oriented towards a *systems view* of creativity; according to this, the modelling of creativity can only rely on the notion that it constitutes an inseparable web of different forces (social, cultural, contextual) that warrant multi-levelled and multidisciplinary investigation.

2.4.2 Technology-Supported Distributed Creativity

Distributed creativity is evidently enhanced, when facilitated by and operationalized through online technology, allowing co-located and remote partners to work and innovate together towards the creative resolution of real problems (Fischer & Shipman, 2013a; Sundholm et al., 2004). Digital social spaces are thus evaluated based on their capabilities and affordances to support two primary constituents of distributed creativity: communication and coordination (Karakaya & Demirkan, 2015a; Sundholm et al., 2004). However, their evaluation is complex due to the multifaceted nature of creativity as well as the tools themselves, since they involve both physical (hardware) and digital components and artifacts, they take place in collocated or remote settings, used by familiar or unfamiliar participants, in synchronous or asynchronous modes (S. W.-Y. Lee & Tsai, 2011). Mangematin et al. (2014) argued that the ‘conceptual creative space’ generated by actors in the creative process (i.e. designers, developers), can be broadened and deepened depending on the technological tools, resources and techniques available (i.e. that may allow instant visualization of ideas and processes). They added that technology can also transform the notion of *sequencing*, by *compressing* or *substituting* the linearly-staged (physical) creative processes, with concurrent interactive episodes.

Such “spatial, temporal, cultural, and technical” (Herrmann, 2009) diversity, should thus be taken into account by research which aims to investigate and provide richer insights into the area of computer-supported distributed creativity.

2.5 Analytical Framework

2.5.1 The Activity Centered Analysis and Design Framework

This work adopts the ACAD (Activity Centered Analysis and Design) framework to guide its analysis and evaluation (Carvalho & Goodyear, 2014a). ACAD was developed with a mind for today's complex social learning networks, in response to the inherent need for in-depth analysis on the multidimensional activities that are distributed across them (P. Goodyear & Carvalho, 2016). Evidently, designers are now dealing with a shift from the 'virtual classroom' to the 'learning city'; the design or analysis should thus appropriate such a reconceptualization. ACAD aims to generate knowledge on the design of compound learning networks to support designers with proactive information that derives from specific scenarios, shaped by their particular technological, pedagogical, instructional and social parameters.

Goodyear and Carvalho (2016) assert that what matters most is *what people do* when they participate in learning networks. They posit that the study of human activity should thus be at the core of the learning analysis. The ACAD framework likewise aims to derive findings in the form of practical actionable knowledge, to assist network designers with clear and realistic guidelines. It clarifies that in defining actionable knowledge, researchers need to first understand the working arrangements (tools, resources, time etc.) that are in place. Following that, findings from the analysis can either a) feed back into the re-design of an existing learning network, allowing for formative 'just-in-time' adjustments, where issues of time and resources become definitive, or b) offer public knowledge in the form of design implications for similar networked learning initiatives across different contexts (Yeoman et al., 2020).

The framework presents distinct conceptual characteristics and propositions that are important for comprehending its philosophy. First, *indirection*, as a key concept signifies that activities cannot be directly designed or prescribed. It is rather the proposed *tasks* or technology arrangements that can stimulate and shape the activities that emerge. As such, it is not possible to ensure that certain designs *will* lead to specific learning outcomes, since it is the activity that "mediates relations between design and outcome" (P. Goodyear & Carvalho, 2016). Secondly, participants of learning networks can - to a degree - make autonomous decisions about *what* and *how* to change things, to enhance and shape network appropriately. Such design evolutions can either happen spontaneously and gradually over time, or they can undertake a rigorous approach with more drastic transformations, as part of a re-design initiative. They can also be externally planned and *imposed* (i.e. by researchers or instructional designers), or can emerge *organically* from within, through the collective actions and configurations of participants, who can 'self-engineer' their network environment. Described as co-configuration in ACAD terms, this phenomenon highlights the need for a) the inclusion of participants in the initial and on-going design/re-design interventions, and b) the use of visual representations (i.e. flows, tools, tasks, operations, roles), to eliminate confusion and bring transparency to the design and operationalization from the start.

ACAD takes into account and analyzes three principle components (see Figure 8) that characterize the activity of collaborative *learning networks* or *communities* (P. Goodyear & Carvalho, 2016; Martinez-Maldonado et al., 2016).

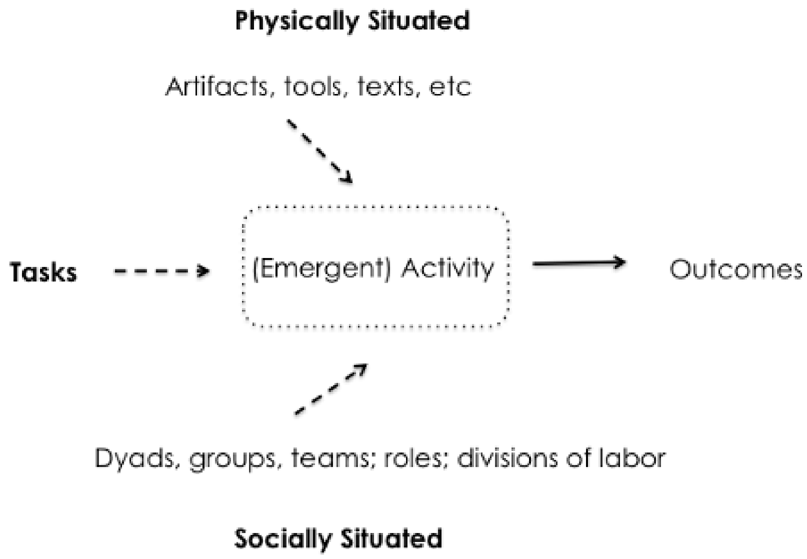


Figure 8: Epistemically, physically/digitally, and socially situated activities and outcomes (P. Goodyear & Carvalho, 2016)

Specifically, these involve the following:

(1) **Set:** the physical, digital or blended setting and the spatial or digital setup, devices, tools, materials and resources that support the learning processes.
(2) **Social:** the social structure of the team, the 'divisions of labor', the roles and responsibilities that members assume, the discourse and decisions that occur,

and the social norms, routines, behavior and habits that shape the knowledge-building activity (Roschelle & Teasley, 1995).

(3) **Epistemic:** the activities that are directed towards an epistemic goal or the tasks that are most connected to learning. These reflect both implicit and explicit elements of knowledge, that materialize in informal or formal settings.

The employment of the ACAD framework to guide the analysis of this research has the following reasoning: a) it is aligned with the educational conceptualizations that underpin SL and CoP theory, in that, it similarly perceives and investigates learning as *physically (*digitally and materially*)* and *socially* situated. The framework was selected due to its capacity "to identify and represent such things as material artifacts, digital tools, social structures, divisions of labor and other organizational arrangements that shape and become shaped by the human activity" (P. Goodyear & Carvalho, 2016), b) it agrees well with PBL, as the instructional model followed for classroom-based processes in this research intervention, which follows a *network-oriented* and *activity-focused*, rather than an individualistic information-transmission model, and c) the variables under investigation (creativity, collaboration, epistemic outcomes, real-world relevance, identity) need to be explored as firmly entrenched as much in the *activity* - which is distributed and mediated through technology - as in the *outcomes* of this activity. For these reasons, the ACAD constitutes an appropriate framework for the top-level analysis of the components of interest (set, social, epistemic), aligning well with the objectives of this research.

2.5.2 The Value Creation Framework

Given the widespread adoption of CoPs as a social theory of learning, entailing a community which is often (partially or fully) technologically supported, Wenger et al. (2011) presented a reconceptualized "foundation for promoting and assessing value creation in communities and networks", called the Value Creation (VC) framework. VC is context-related and refers to the objectives of the community and the *value* that participants attain from their learning memberships in that. Grimaldi et al. (2012) posited that for communities of innovation (a type of a CoP in organizational contexts), intellectual capital is key, as it constitutes a significant component in employee performance and overall firm competitiveness. Likewise, the VC framework places the learning *activities*, the co-created *knowledge*, the *social/human* structure, the inherent *relationships*, the *artifacts* developed, the emerging *prospects*, their *transfer* into practice, their *effect* and influence on *identity*, at the core of its evaluation. Thus, learning in CoPs can be assessed rigorously and reliably through the framework's five cycles (see Figure 9). These are not exclusive, nor consecutive to one another, neither do they have to fully materialize to signify *value* (Kirkpatrick, 1975; E. Wenger et al., 2011). Specifically, the cycles reflect learning of:

(1) ***Immediate value***: the members' activities and exchanges (sharing stories, asking/responding, solving problems) to serve the purpose of the practice.

(2) ***Potential value***: the 'knowledge capital' co-created during practice. Even if this may never be applied, it holds value in itself and is categorized as:

- ***Human* capital**: knowledge, skills, changes in attitude (i.e. motivation, sense of importance, confidence)
- ***Social* capital**: networking, relationships, shared understanding
- ***Tangible* capital**: useful resources (tips, tools, documents) accrued
- ***Reputational* capital**: perceived significance of the CoP membership and the status and reputation that gradually develop
- ***Learning* capital**: ability to learn socially and transfer meaning into other contexts

(3) ***Applied value:*** the application and integration of knowledge into practice (i.e. exploring ideas, developing solutions)

(4) ***Realized value:*** the value of outcomes, performance improvements, quantifiable results

(5) ***Reframed value****:* a reformed understanding of learning and success criteria

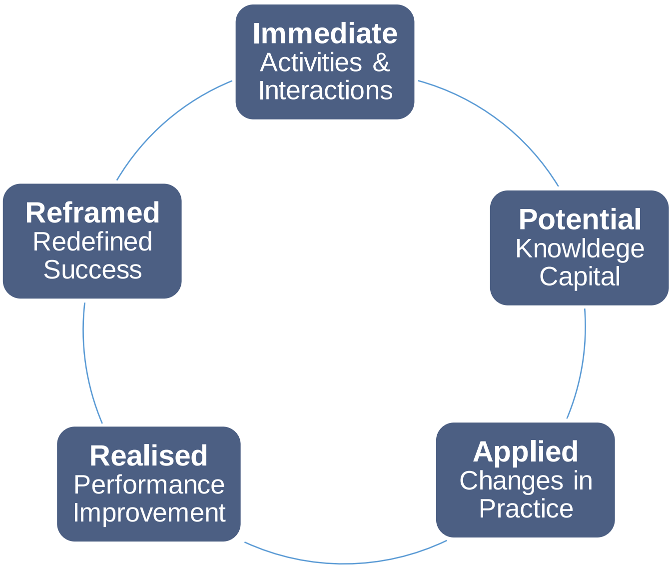


Figure 9: Value Creation framework cycles

According to the VC framework, it is vital for researchers to capture phenomena that evolve in a CoP's practice, mainly through the participants' stories, in the form of individual and collective *narratives*. The framework provides researchers with specific indicators in these narratives, that can then be matched against representative accounts of VC. Indeed, in their work on four online educator communities, Booth and Kellogg (2015) documented such connections between *indicators* in the narratives and respective *VC outcomes*. In doing so, they were able to first, examine the framework's potential to assess learning, and then derive implications for assisting "researchers and community managers to better understand the impact of participation in online communities of practice" (Booth & Kellogg, 2015).

Hence, by enabling researchers to identify the links between specific CoP phenomena to VC outcomes, the importance of the framework lies as much in its *evaluative* role, as in its ability to provide *proactive* gear for the *design* and cultivation of VC in learning through CoPs (E. Wenger et al., 2011).

2.6 Empirical Work and Evaluation Approaches

2.6.1 Empirical Work Framed by CoP theory

This work builds on an existing body of research that has evidenced both the positive effects, as well as the challenges encountered in CoPs. A large part of this analyzed

CoPs based on their enactment and outcomes (A. DeChambeau, 2017; Gaillard & Rajic, 2014), while others have gone further to provide practical implications, heuristics and models for the design, facilitation and evaluation of CoPs, in the educational (Gunawardena et al., 2009; Moule, 2012; Nistor & Fischer, 2012), business (Borzillo et al., 2012; Hafeez et al., 2019; Probst & Borzillo, 2008) and public/government sectors (Bate & Robert, 2002; Pattinson & Preece, 2014; Tangaraja et al., 2015). These are discussed in the following sections.

2.6.1.1 Education-Based CoP Research

Lea et al. (2005) described CoP theory as "one of the most articulated and developed concepts within broad social theories of learning", with an extensive set of applications in different pedagogical contexts. Respective empirical interventions recorded several benefits of the theory, in fostering *self-development* - mainly through *legitimate peripheral participation* (Stone et al., 2017; Woo, 2015), enhancing *reflection* skills (A. J. Rourke & Coleman, 2009), evolving the ability to network and *co-create knowledge* (Allee, 2000; Hildreth & Kimble, 2004), and leading to *innovation* (V. Goodyear & Casey, 2015) and *professional growth* (Khalid & Strange, 2016; Tseng & Kuo, 2014).

CoPs have reportedly been adopted to attain similar learning benefits within a wide range of disciplinary contexts. These include health-care (Moule, 2012; Woods et al., 2016), STEM (Asoodar et al., 2014; Hodgkinson-Williams et al., 2008; Moulton et al., 2017), architecture (Morton, 2012), business/management (Albrecht, 2012), language-learning (Nagao, 2017), teaching and learning (Matthews et al., 2017), arts education (A. Rourke & Mendelssohn, 2017; Sawyer, 2006), and in interdisciplinary learning contexts (Pharo et al., 2014).

While noticeable in all education, the adoption of CoPs has been particularly widespread in HE (graduate and post-graduate), where learning is more autonomous and involves more informal forms of guidance and supervision (Johnston, 2016; Wisker et al., 2007). DeChambeau's (2014) research for instance, evolved around a CoP of doctoral students in Education studies and demonstrated the positive effects of their participation on (reducing) isolation, achieving work-education-life balance, and becoming positive and successful scholars. By analyzing student narratives, the work derived respective *indicators* of learning success, these being the increased scholarly abilities, higher levels of personal accomplishment and growth, identity transformation (i.e. building confidence), and the cultivation of lifelong learning skills. Within the same educational context, Crossouard and Pryor (2008) also highlighted the capacity of CoPs to offer opportunities for meaningful *formative assessment*, as part of a doctoral students' discussion forum. They argued that the student-supervisor review processes, and most importantly, the *peer subgroups* that developed in the CoP practice, helped "illuminate assessment as a social practice". Indeed *assessment* and *feedback* presents itself as a powerful benefit of CoP participation, that cannot be ignored, especially since learning is given the chance to be infused with extended knowledge and feedback from a diverse set of stakeholders.

One early example of such a case study, came from Squire's & Johnson's (2000) work, who set up distributed CoPs among three teams of secondary education *students* from different schools, *experts* from the industry, and various *faculty* members. The three groups had to develop three different Design-based projects (a website, a toy prototype, a musical benefit and companion recording). CoP participants connected systematically via an LMS, and an interactive television (ITV) system for real-time interaction, to provide and receive feedback from peers and experts. In the ITV sessions, the feedback process targeted not only the *products* but also the *processes* leading to these. Findings from the study indicated that a) students interacting with students as *peer evaluators*, engaged in 'rigorous commentary' and became able to critically analyze and challenge each other's ideas effectively, and b) students interacting with experts generated higher levels of motivation, making them more eager to participate in the CoP, not only for project development purposes, but also for the opportunity to discuss design practice and build social relationships with experts in their field. This confirms the direct link between CoP-based *feedback* and *assessment*, and the formation of learners' *pre-professional* identities at the early stages of education; supporting Boud's & Falchikov's (2006) assertion that what education lacks is a new "conceptualization of the place of assessment in learning beyond the academy" and the ways that this is integrated into formal HE to empower students with more situated knowledge of their future professions.

2.6.1.2 Professional Faculty Development Through CoPs

A large number of CoP studies involve initiatives for the professional development of faculty (teachers, instructors, administrative staff), employed both within and across different institutions (McLoughlin et al., 2018; Tseng & Kuo, 2014). Kezar et al. (2017) specifically investigated a large-scale CoP, which developed as part of a faculty development and STEM education reform incentive, reporting quite positive learning results; such as members becoming engaged in the community's philosophy, forming social mentoring relationships, brainstorming, getting advice and supporting each-others' professional development processes. Likewise, Stone et al. (2017) reported on a self-initiated CoP amongst faculty members from three academic institutions, during their merging process. Through their common practice they shared a considerable amount of knowledge and resources, using web-conferencing and asynchronous tools, to develop skills for managing a new LMS platform that would support the merged learning activities. Their findings suggested that participants were able to build *trust* amongst them and develop *confidence* in using technology to connect and learn with and from each other. Interestingly, their investigation also extracted requirements for further research looking into the challenges of *power* and *leadership* that are typically encountered in large-size CoPs.

2.6.1.3 Organization-Based CoP Research

A significant contribution in the area of organizational CoP literature was made by the work of Probst and Borzillo (2008). Importantly, these authors stressed that literature is in need of *governance models* and *mechanisms*, to guide stewards in steering and managing CoPs, to assist in reaching their full potential and achieving strategic advantage. They proceeded to offer new ways of understanding different CoP participation patterns in the organizational sphere and deliver governance mechanisms for the respective types of *managed CoPs* (Borzillo et al., 2011). They also focused on developing and sharing best practices, and promoting innovation through CoPs in specific sectors (Borzillo, 2009; J.-F. Harvey et al., 2015; Probst & Borzillo, 2008).

Other prominent research involving organization-based CoPs includes Smith's and McKeen's (2004) study which offered design and facilitation guidelines which focus on knowledge management for CoPs in enterprise-level contexts. Further work in the same areas, includes Pyrko's (2017, 2019) research, who amongst others, presented a LoPs model (see section 2.3.6) to support the *local* and *global* practices of CoPs in organizations, as well as Fuller et al.'s (2005) study, which investigated workplace learning with a focus on *apprenticeship*, providing guidelines for understanding the nature and process of workplace learning through the lens of CoPs.

2.6.1.4 CoPs in the Mediation of Real-World Practice and Professional Enculturation

Authentic education can help novices gain access to the practice of a professional community and develop real-world preparedness (Herrington et al., 2014). Lombardi (2007) suggested that instructors and learners can harness the recent technological advances to learn about the past and current real work phenomena, and connect with remote mentors to gain deeper understandings of their discipline. In this way "learning becomes as much social as cognitive, as much concrete as abstract, and becomes intertwined with judgment and exploration, just as it is in an actual workplace" (Lombardi, 2007).

Grounded in conceptualizations of situated and authentic learning, CoPs constitute a model that appropriates these objectives well, through their capacity to bring various stakeholders together, and infuse the academic practice with *authenticity*. This helps cultivate the necessary skills for the pragmatic transformation of *identity* into its professional dimension (Jackson, 2016). One such authenticity-driven empirical approach, focused on the *semantic* constituents of a discipline's practice. Specifically Morton (2012) posited that in the Design disciplines, the *studio* (used for critiquing and social knowledge-building) is seminal for mediating real-world relevance in a community of (architecture) scholars, since it also constitutes a primary component of the industrial practice (Adams et al., 2016; J.-F. Harvey et al., 2015). Likewise, from a technology perspective, Novakovich et al. (2017) emphasized the role of social media networks and sound professional social media skills, as these were found to be constitutive of students' professional identities while still at university. Their study integrated a *social media* network to serve as a community and a coursework platform for students. While findings uncovered an initially large gap "between students' everyday practices on social networks and professional practice" (Novakovich et al., 2017), they also indicated significant enhancements in their *engagement*, *beliefs* and *goals* in terms of their professional social media skills development, following the intervention. The authors also offered a set of practical propositions as guidance for the integration of social media skills development in the university curriculum.

Other authenticity-driven approaches employed researchers to become involved in education. Specifically, Gilbuena et al.'s (2015) study discussed the potential of small CoPs of engineering students and a researcher, in producing deep and meaningful feedback through regular coaching. Additional studies of similar aims, took an interim step of authenticity, by investigating CoPs that transcended the boundaries of different disciplines and institutions, but still remained within the *academic* sphere (i.e. universities) (Jeffs et al., 2016; Pattinson & Preece, 2014; Pharo et al., 2014).

Other studies investigated the benefits and limitations of CoPs that developed in *work-placement* schemes (Johnston, 2016). Brown's (2015) study for instance, focused on interns' perceptions of their participation in a (physically situated) workplace CoP. The study suggested that multimembership in *academic-based*, *student-driven* and *industry-based* practices, required students to become well-versed in these three different languages and develop *peripheral* or *full* types of participation in each of these. Evidently, this enhanced the interns' communication skills, flexibility, and fluency in problem-solving and in handling situations that emerge in diverse contexts. Findings from the intervention also uncovered that one of the CoP's main contributions for interns, was the opportunity to observe job supervisors (CoP experts), facilitating good informal LPP and strengthening their reflection skills. However work placements may present certain limitations that are discussed in section 10.3.5.1.

A CoP-based approach to promote *authenticity* and real-world relevance by Rourke and Mendelssohn (2017), proposed the involvement of students in communities outside the university (while still in university) as an effective method. Daniel (2008, as cited in A. Rourke & Mendelssohn, 2017) also emphasized the same need, that is, to initiate communities of *reflective practitioners* within education, prior to practice. Aligning with this, Albrecht's (2012) empirical study in tourism education, invited industry guests to give lectures in undergraduate and postgraduate courses, and deduced that this form of *authentic* learning approach added "an applied dimension to tourism higher education while simultaneously providing inspiration for career choice".

Focusing on conceptualizations of *cross-organizational* CoP approaches, Jackson (2016) drew upon CoPs to theoretically frame the potential development of students' pre-professional identity (PPI) in university. The study explained PPI as the "understanding of and connection with the skills, qualities, conduct, culture and ideology of a student's intended profession" and considered this critical for graduate employability. Using the LoPs concept (see section 2.3.6), it proposed the merging of academic and external bodies (i.e. careers services, student societies, industry employers) in educational CoPs, and derived respective design implications. Jackson's (2016) study provides solid theoretical grounds, insight and motivation for the empirical application of *cross-organizational CoPs* in HE, a direction that comes in full alignment with the objectives of this research.

Finally, a review of literature with a focus on authenticity has extracted one empirical study on *cross-organizational* CoPs. Specifically, Iskanius and Pohjola (2016) examined the role of CoPs in the joint development (university-industry) of a research and innovation platform (in arctic research), aimed at sharing scientific knowledge and contributing to regional *innovation* development efforts. While the intervention's focus was *research* - rather than *education* - it still highlighted the merits of such partnerships in facilitating substantial tacit knowledge transfer across diverse stakeholders. These presuppose a *shared interest*, a level of *trust*, as well *as an 'insider'* member status, which in CoP terms, is understood as a *legitimate* participant.

2.6.1.5 Challenges Faced in CoP-Based Learning

As with all social formations, CoPs also face considerable challenges throughout their life span. In fact, Wenger (1998) discussed this matter, cautioning that the picture of CoP participation is not always optimistic. Several issues emerged from studies, in both educational and organizational contexts and across collocated, blended and online CoP settings (Crossouard & Pryor, 2008; Hsu et al., 2007; Waycott et al., 2017). Explicitly, participation and engagement in CoPs was found to be largely influenced by *socio-affective* factors such as *trust* (inter-personal / intra-personal), competition, and individual beliefs, intentions and predispositions. Under certain circumstances, these may lead to unhealthy expressions of power and subsequent social tension and conflict (Fox, 2000a; Roberts, 2006).

In their study, Chang et al. (2008) rejected the assumption that all students, as community members, willingly engage in the community's knowledge-sharing activities during coursework practice. The fear of *opportunism* (i.e. personal ideas and work stolen by dishonest peers), and *competition* avoidance were two good reasons for this outcome (Fang & Chiu, 2010). Such issues were also observed in communities whose members suffered considerable *lack of trust*, either based on past (vicarious) experiences (Bandura et al., 1999), or due to limited *relational* and *geographical* proximity. In this context, Roberts (2006) argued that relational proximity (the degree to which individuals relate to each other based on similarity) may be more important than geographical proximity (presence), which can instead be mediated through the use of ICT (Amin, 2002; Moodysson & Jonsson, 2007a). However, a number of studies suggest that exclusive online communities may fail to cultivate sufficient *relational proximity* and *trust* amongst their members. As Nilsson (2019) asserted, the reason why trust is often associated with collocation, is because physicality urges people to invest time and effort to build sustainable social bonds. In contrast, communities deprived of such colocation opportunities may be prone to more severe lack of participation (Aljuwaiber, 2016; Booth & Kellogg, 2015; Matzat, 2010).

VCoPs have indeed been found to face an increased amount of such challenges, compared to those in blended settings. Waycott et al.'s (2017) work uncovered serious issues relating to *online social practice* that seemed to undermine CoP participation. These documented: a) a phenomenon dubbed *virtual panopticon*, which reflects the perceived risk of public exposure, intense audience awareness, vulnerability, fear of criticism, and consequent careful self 'curations' (versus authentic and spontaneous expression) (Crossouard & Pryor, 2008), b) the perceived *lack of authorial identity*, that is, not having full credit for the individual contributions that often become blurred in collaborative activities (Dennen, 2016; Waycott et al., 2017), and c) *context collapse*, that is, the lack of clear distinctions between *academic* and *personal* social media activity (Dennen & Rutledge, 2018; Vitak et al., 2012).

Additionally, issues of *power*, intertwined with the levels of participation, are often inherent in CoPs. According to Roberts (2006) "members who have full participation will have a greater role and therefore are likely to wield more power in the negotiation of meaning". Yet, if not carefully managed, power issues can have adverse effects on others’ participation and learning patterns; what is described by Wenger (2016) as the ‘*silencing of voices’* in a community.

In line with the above, Probst and Borzillo (2008) have determined the reasons behind success and failure in organizational CoPs, and drawing upon these, delivered prescriptions for effective CoP governance. Five common reasons of failure involved the *lack of a core group* to drive the flow of ideas and problem-solving activity, *low degree of one-to-one* member interactions, reluctance to *rely on others’ competences*, *lack of identification* with the CoP’s objectives, and *practice intangibility*, that is, the CoP’s inability to effectively *reify* its practice for members to understand and *engage* in.

The contribution of studies reporting on the challenges encountered in CoPs (education-organization-based) is significant, as it informs new research with proactive knowledge and direction for CoP design and facilitation.

2.6.1.6 Evaluation Approaches and Methods in CoP Research

Theory suggests that CoP studies have mostly followed mixed methods approaches to investigate, analyze and explain social learning. Depending on their objectives, studies involved different data-collection methods. Qualitative methods included observation (Borzillo et al., 2012; Crossouard & Pryor, 2008; Pyrko et al., 2019), reflective diaries, blogs or journals (A. J. Rourke & Coleman, 2009; A. Rourke & Mendelssohn, 2017), interviews and focus-groups (Booth & Kellogg, 2015; Aimee DeChambeau, 2014; Trust & Horrocks, 2017), open-ended surveys (Barnett, 2014; Duncan & Barczyk, 2013; Moule, 2012), feedback-producing workshops (Grimaldi et al., 2012; Iskanius & Pohjola, 2016) and reviews of artifacts (C. M. Johnson, 2005).

Quantitative methods involved prominently online/offline surveys (Duncan-Howell, 2010), measured activities and interaction logs (posts, reviews, communication, chats, shares/retweets conferencing) (Martínez-Arbelaiz et al., 2017), and (scraped) text-data for quantitative processing (Komorowski et al., 2018).

Data analysis in CoP studies largely employed thematic analysis on transcribed qualitative material (i.e. conversations, diaries, interviews, videos), constant comparative analysis (an inductive - grounded method), content analysis (involving reliability testing), time-series analysis (sequential observations over time) and qualitative/quantitative causal mapping and network techniques (Crossouard & Pryor, 2008; Dzidic et al., 2017; Pyrko et al., 2019). It should be noted that CoP studies relying solely on *quantitative* data and analysis are scarce, whilst the opposite holds true in a number of cases. For instance, small-scale studies on physical or blended CoPs often employed qualitative-only methods (A. DeChambeau, 2017; Frith, 2014), while studies on online CoPs with larger memberships in public digital platforms, typically followed a mixed methods approach to their investigation (Komorowski et al., 2018; Mamykina et al., 2011).

Aside of mixed methods, CoP studies were also framed as *explorative, ethnographic,* (single or multiple) *case studies*, and less so as *experimental*/*quasi-experimental* designs (Booth & Kellogg, 2015; Frith, 2014; J.-F. Harvey et al., 2015; Sinclair & Levett-Jones, 2011).

CoP studies aimed to extract rich data sets, to enhance their trustworthiness through thick descriptions and triangulation (Novakovich et al., 2017; Spagnoletti et al., 2015; B. Wenger-Trayner et al., 2019). Spagnoletti et al. (2015) for instance, used a *two-phase* research method to validate and derive design propositions for digital platforms in CoPs. In both phases, they collected and triangulated data such as platform design material (i.e. prototypes, presentations), communication and collaboration evidence (i.e. emails, meeting notes), as well as audio and video recordings of focus-group sessions. While the first phase concentrated on a self-designed platform to derive propositions, the second reviewed other popular online communities (i.e. Twitter, Wikipedia) to test these propositions and generate new insights.

The use of social networks has evidently been prevalent in CoP interventions, the majority of which employed social network analysis, followed by content analysis of posted material (i.e. prominent words and phrases) to determine the discussion topics of the practice (Duncan & Barczyk, 2013; Patahuddin & Logan, 2015; Zhang, 2010).

Other studies have utilized automated tools to serve particular methodological requirements. For instance, using an exploratory mixed methods approach, Komorowski, et al. (2018) investigated the role of Twitter in the practice of four blended CoPs. Specifically, they first conducted semi-structured interviews and observations to gain understanding of the communities' social structures, and then developed a crawling engine to collect demographic and behavioral data (language, location, number of followers, original/retweeted posts, likes, relationships) from the members' Twitter accounts.

Discussing the significance of social networks and social network analysis in the understanding of CoP practice, Wenger (in Farnsworth et al., 2016) explained that while this method can extract useful top-level results, it lacks the deeper insights about learning as a *lived social experience*, stressing that "network theories do not focus on the experiential aspect of meaning making" that is of critical importance in CoP research.

2.6.2 Empirical Work in Creativity Research in Design and HCI Contexts

2.6.2.1 Distributed Creativity in Multiple Domains

Collaborative, collective, social or *distributed* creativity has been the focus of more contemporary work of different scope and within different disciplines. These ranged from the inherently creative areas such as the arts, design and multimedia (Dalsgaard et al., 2015; Giglio, 2015; Sawyer & DeZutter, 2009; Uzzi & Spiro, 2005; Weakley & Edmonds, 2005), to neighboring fields such as HCI and information technology (Bačíková, 2015), to the *social* (Haller & Courvoisier, 2010), the *scientific* (Charyton & Merrill, 2009; Chiu, 2008; Scott, 2015), and the *business* domains (Kurtzberg & Amabile, 2001; Sigala & Chalkiti, 2015), as well in *multi-disciplinary* contexts (Wagner, 2017). Some studies have also expanded their research scope to the investigation of collective creativity as a 'creative massive online collaboration' phenomenon (Roque et al., 2016).

In order to align with the focus of this work, we located relevant work on creativity within the context of HCI, an area which is inherently linked to Design – particularly digital interactive Design - and inform the reader how HCI and creativity converge, both in theory and practice, next.

2.6.2.2 Design and HCI-Oriented Creativity

Although primarily linked to the *artistic* domain, creativity is also crucial in seemingly dissociated areas, like the science, technology and engineering disciplines (Cropley, 2015; Kaufman et al., 2012; Wagner, 2017). This section concentrates on the specific link between *creativity* and *HCI,* two disciplines which evidently share an "overlapping existence" (Kuutti, 2009) in theory and practice. Particularly, HCI is integrally linked to Design, and the digital creative domains to be specific, since in these contexts, success is related to the users' effective interaction with the produced artifacts, thus employing a user-centered design (UCD) philosophy in their product development processes.

It should be noted that the intersection of HCI and creativity can be understood in light of two perspectives. First, creativity as an integral component of the HCI *process* and *outcomes*, and secondly, creativity as the *object* of *study* in HCI; the latter concerns how HCI guides the development of systems that can support human creativity. Both relate to the rationale of this research and are discussed below.

2.6.2.3 Creativity as Part of the HCI and Design Processes and Outcomes

HCI processes in education and practice presuppose the actions of both *finding* and *making*; that is exploring and understanding human-computer-related phenomena and using these to support the *ideation* and transformation of concepts "into new constructs" (Finken et al., 2014). This occurs through the critical questioning and problem-solving processes of a Design team, driven by the purpose to deliver novel, safe and usable products to end-users (McCrickard et al., 2013; Oulasvirta & Hornbæk, 2016).

Important creativity dimensions therefore highlight and justify the irrefutable link between creativity, Design and HCI. Amongst others, creativity sub-constructs such as *divergent thinking* and *innovation* also constitute major objectives of the HCI process, involving lateral, experimental, intuitive, risk-taking, affective and generative approaches to thinking. *Convergent thinking* on the other hand, is also required as an associative, integrative, critical-thinking activity, that adds focus and extracts judgments from arbitrary and diverse ideas, guided by a specific purpose (i.e. an end product) (Jaarsveld et al., 2012). Further, *appropriateness* for a real-world purpose, as judged by a social audience, is crucial for design outcomes (Chilana et al., 2015; Finken et al., 2014). Sufficient prior *subject-knowledge* is also important in achieving the generative / integrative creative activities (divergent/convergent thinking), as the *reuse* of earlier knowledge facilitates the production of new knowledge in context of a purpose (McCrickard et al., 2013). Hence, the same components of *creativity* constitute key objectives of *HCI* and Design research and practice alike.

Over the past two decades, interaction design (an HCI sub-domain), has thus widely adopted *design thinking,* a philosophy that promotes *open-endedness* and "creative-insight" (Finken et al., 2014; Pierce et al., 2015) to fundamentally support team creativity (Candy, 2013; Frich et al., 2018). Design thinking involves a cyclical process of *inspiration*, *ideation* and *implementation.* Collective brainstorming, the expansion of the problem-space through multiple perspectives and ideas, visual externalizations (i.e. diagramming, prototyping), and user-testing, are considered fundamental activities in the design and development processes (Bhatnagar & Badke-Schaub, 2017; Zimmerman & Forlizzi, 2014). Coinciding with this, interaction design processes in HCI are predominantly collaborative, often materializing in multidisciplinary team conditions (i.e. researchers, programmers, designers, psychologists), requiring diverse inspiration, ideation and creative meaning-making processes.

2.6.2.4 Technology-Supported Creativity as the Object of Study in HCI

The area of technology-supported *creativity* is a relatively new perspective in HCI (Frich et al., 2018). As creativity-oriented HCI research has so far been concerned with *computational creativity*, that is designing creativity systems, it is considered to be 'fragmented', as it lacks the perspective of enabling the entire process of human creativity – both individual and collective. Evidently, this can be augmented through the contribution of generic creativity research (CR), that is part of the psychology domain (Hoffmann, 2016); that is, to design socio-technical systems that facilitate an all-encompassing form of *creativity*, HCI sought to broaden its investigation to integrate fundamental CR variables, such as the *people*, *processes*, *products* and *context* (M. Rhodes, 1961). This requires a more systemic HCI approach that seeks to shape a solid understanding of human *creativity* and *collaboration*, accelerating in this way, the "process of disciplinary convergence" (Shneiderman et al., 2006). Hence, there is a current critical need for joint research, accommodating phenomena that fall under the lens of *creativity,* which involves both *computers* and *humans,* as the two main areas of interest in HCI and Design practices (Hoffmann, 2016).

2.6.2.5 Evaluation Approaches and Methods in Creativity Research

The evaluation of *creativity* has taken on a number of different approaches over the years (Cherry & Latulipe, 2014; Shneiderman et al., 2006). These involved looking into the individual (creative-cognitive) abilities, personality traits and inclinations (Crilly & Cardoso, 2017), the creative processes, both individual (i.e. cognitive) and collective (Mednick, 1962), the socio-cultural context (Plucker et al., 2004), the epistemic domain (Furnham et al., 2011; Kaufman & Baer, 2005) and the creative products (Horn & Salvendy, 2006; Zeng et al., 2009).

Data collection methods in creativity evaluation has most prominently employed psychometric instruments for personality and attitude testing (Acar & Runco, 2014; Plucker et al., 2004), interest inventories and activity-based tests (Carson et al., 2005; Gough, 1979; Torrance, 1966), performance observations (Meneely & Portillo, 2005), external (expert/non-expert) *product* creativity assessment (Amabile, 1982; Horn & Salvendy, 2006; Zeng et al., 2009) and the extraction and analysis of various computer-generated data (i.e. activity logs) (Karakaya & Demirkan, 2015b).

Analytical approaches in creativity research have mostly involved verbal protocol analysis (D'souza and Dastmalchi 2016; Gero and Kan 2016; Lee 2014; Tang and Gero 2000), interaction and video analysis (Sawyer & DeZutter, 2009), thematic analysis (Crilly & Cardoso, 2017), content analysis (McKenna & Chauncey, 2015), statistical analysis of self-reported and externally-rated tests (Plucker et al., 2004; Runco et al., 2014), and product ratings (Amabile, 1982; Horn & Salvendy, 2006; MacKinnon, 1962; Zeng et al., 2009).

It should be emphasized that the majority of these approaches measure individual creativity (Gough 1979; Runco 2007; Runco et al. 2014), and many studies followed this perspective through the use of established tests and scales. A few prevalent examples include the '*Torrance Test of Creative Thinking*' (TTCT) (Almeida et al. 2008; Kim 2006; Torrance 1966), the '*Kaufman Domains of Creativity Scale'* (K-Docs) (Kaufman, 2006; Kaufman et al., 2009), the 'Creativity Assessment Battery' (rCAB)© (Acar & Runco, 2014) and the '*Creative Achievement Questionnaire'* (Carson et al., 2005; C.-C. Wang et al., 2014).

However, this diversity in the evaluation approaches indicates that creativity warrants on the one hand, more depth and specificity in each dimension, and a more *unified* approach that sees these working as part of an *entangled* system, on the other (Hennessey, 2017; Mumford, 2003). Aiming to capture creativity in a more systematic way, Batey (2012) proposed a taxonomic three-dimensional analytical framework.

According to this, creativity investigators need to define the *level* (i.e. team, organization, culture or individual), the *facet* (i.e. trait, press (environment), process or product) and the *measurement* that is most appropriate for collecting creativity-based data in a study (i.e. objective, self/external rating, objective methods). A few more similar approaches with a focus on distributed creativity are mentioned in the next section.

2.6.2.6 Evaluation Approaches of Distributed Creativity

The evaluation of distributed creativity (DC) is still under-explored in literature (Farh et al., 2010; S. Harvey, 2014; Kurtzberg & Amabile, 2001; P. B. Paulus & Baruah, 2018; Yuan & Zhou, 2015). A few studies have approached DC by making qualitative observations in brainstorming teams and documenting their collective creativity episodes (P. B. Paulus & Nijstad, 2003). Using protocols to code the team processes, some categorized *distributed* creative collaboration, through interaction and conversation analysis (Sawyer and DeZutter 2009), while others focused on the analysis of activity and discourse logs in digital collaborative systems (Karakaya & Demirkan, 2015b; Scott, 2015). More automated methods were also employed, involving computer-mediated discourse analysis (CMDA) for the examination of creative episodes in group communication (chats) (Scott 2015).

On a simpler level, and adhering to the role of self-reported methods in the investigation of natural - versus lab-based - *team processes*, Batey (2012) proposed that collective results can be extracted using the taxonomic framework, through a *team-rated creativity questionnaire* or by aggregating scores from *individually-rated questionnaires*.

In need of more exhaustive understanding of distributed creativity phenomena, studies took a more integrative approach to their investigation (Sundholm et al., 2004). For example, Karakaya and Demirkan (2015) used a blend of analytical approaches and methods to assess the interactions between the *individual* and the *social* aspects of creative collaboration between students in HE. A series of online posts and comments from participants (in blended learning teams) formed the units of analysis. In addition to Amabille's and Pillemer's (2012) componential theory of creativity (CAT), used for *protocol-coding* the *intra-individual* components, the study also used a) Calvani's (2010) interaction model for indicators of *social* collaboration, and b) Jonassen's and

Kwon's (2001) Functional Category System (FCS) for indicators of *communication* and *feedback*.

2.6.2.7 HCI Perspectives in the Evaluation of Technology-Supported Creativity

The complex, multi-faceted nature of creativity generates many challenges for its evaluation, including those seeking to evaluate *creativity-support* platforms and tools (Cherry & Latulipe, 2014; Shneiderman et al., 2006).

In HCI, the boundaries between *creativity-support* and *usability* evaluation are blurred and often fused together to extract aesthetic quality and usability, which involves the degree of learnability, efficiency, memorability, error incidence and user satisfaction obtained from the interaction with a system/application/interface (Nielsen, 1994b). Evaluation in HCI typically employs a blend of *qualitative* methods in lab and field-based studies such as observations (Burkhardt et al., 2009), concurrent/retrospective think-aloud methods, interviews (Cooke, 2010), and *quantitative* approaches such as software-log analysis (Laux et al., 2016), time-on-task scores (Harrati et al., 2016), and self-reported (product) evaluations (Brooke, 1996; Orfanou et al., 2015; Parung & Bititci, 2008). Alternatively, eye-tracking methods (Jacob & Karn, 2003; Nielsen & Pernice, 2010; X. Yang et al., 2016) are often combined with cognitive walkthroughs – or in the case of collaborative teams - groupware walkthroughs (Pinelle & Gutwin, 2002) to derive usability and creativity-based inferences. However, *time* and *budget* limitations have often dominated the selection of evaluation methods for usability and creativity alike, and redirected evaluation toward low-cost, fewer-resource and rapid assessment techniques, such as Nielsen's (1994a) *discount usability* approach for instance.

However, it is clear that basic *usability* and *task-oriented* methods (i.e. effectiveness, efficiency, user clicks, time-to-completion etc.) are not sufficient for capturing the *complex* nature of computer-supported (individual or distributed) creativity. Additionally, these methods were often criticized for limiting understanding to *objective* and *controlled*, (i.e. in-vitro) phenomena, which come into conflict with the ill-structured, exploratory and fluid nature of creativity (Frich et al., 2018; Shneiderman et al., 2006). Research has thus called for the investigation of the real *situated* experiences of the people involved, with particular emphasis on the *cognitive*, *perceptual* and *affective* perspectives of creativity-support systems instead (Candy, 2013; Hassenzahl, 2004).

2.7 Discussion of the Literature Review Findings

2.7.1 Knowledge Gaps in CoP Literature

The review of literature on CoPs in education, has identified a number of gaps, which justify the call for further research based on new objectives. These are discussed in the following sections (see Figure 10).

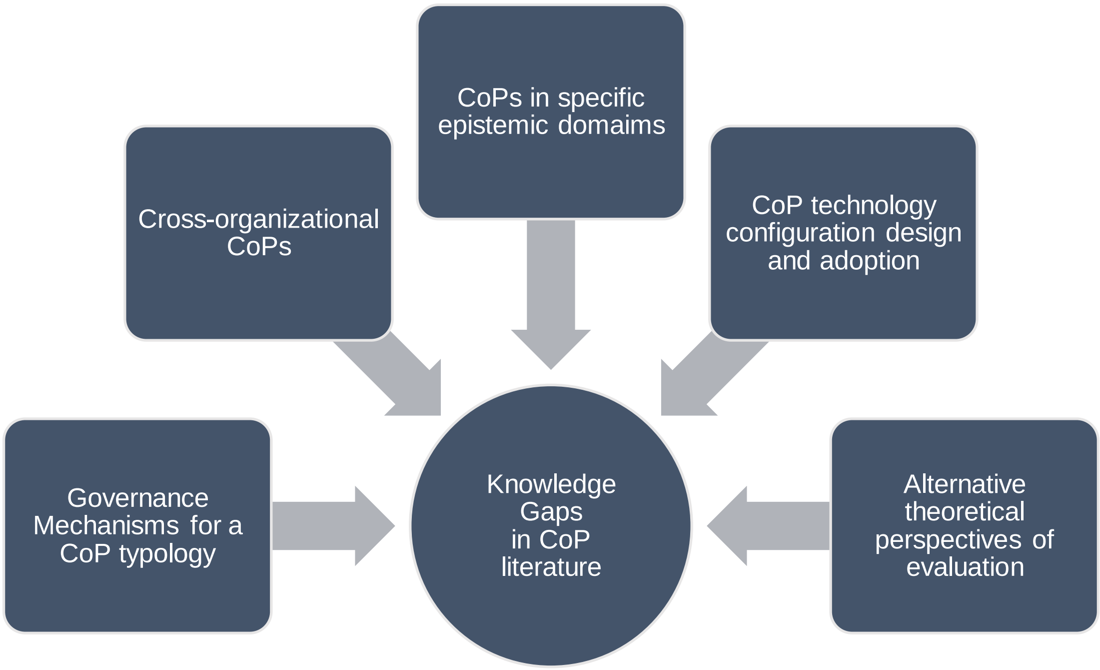


Figure 10: Key knowledge gaps in CoP literature

2.7.1.1 Governance Mechanisms for a Typology of CoPs

Wenger (2010b) suggested that CoP *governance*, driven by social learning aims, should reflect the character and structure of specific communities, and went on to suggest two supplementary forms of governance: a) *stewarding governance*, that is, trying to manage the community's practice towards specific purposes, and b) *emergent governance*, that is, making ad-hoc, 'just-in-time' steering judgements, that are formed in response to emergent situations in the practice. Within this context, Dubé et al. (2005), argued that a '*one-size-fits-all'* type of governance (whether stewarding or emergent) is not suitable for different types of CoPs and their unique characteristics as these “may be more or less conducive to success”. They asserted that a classification of CoP types, in terms of structural and operational features (i.e. size, geographical/relational distance, spread, synthesis, purpose) is critical before attempting to produce appropriate *governance* schemes. Indeed, Hodkinson (2004) also postulated that studies should be more concerned with identifying and reporting on the *special* characteristics of different CoPs, rather than merely verifying their existence based on their compliance with theoretical criteria. This objective was shared by Borzillo (2017) through his intend to “gain more comprehension of different types of CoPs and the governance processes and knowledge strategies that characterize them”. As it stands, there have been several such contributions on CoP *governance* in literature, which concerned mainly professional - rather than educational – CoPs (Borzillo, 2009; Dubé et al., 2005; Probst & Borzillo, 2008). However, the need for more targeted governance directions appears to transcend the organizational sphere, and is of similar importance in education-based CoP research (De Moor, 2015; Keller, 2017; Perkmann & Walsh, 2007).

Consequently, literature is still in lack of guidance on the specific and comprehensive *governance* schemes that can help manage educational CoPs with specific characteristics (Keay et al., 2014; Probst & Borzillo, 2008). We posit that a *cross-organizational* CoP model, integrated within a *blended* learning setting in the Design and relevant educational fields, with an aim to enhance learners’ creative, epistemic and professional adeptness, presents one such classification, and thus provides clear research directions in this work. These are examined individually in the following three sections.

2.7.1.2 Cross-Organizational (Industry-Academia) CoPs

HE still faces significant challenges in de-isolating itself, in improving and mitigating the skills-gap between itself and the industry by equipping graduates with sufficient skills and adequate relevance to the real-world practice. Considering the history of calls for educational reform through the industry’s input into the curriculum (Horizon 2017, 2019), the dynamics, prospects and outcomes of such collaborations still remain largely underexplored in literature (Jackson, 2016; Turbot, 2015). A possible cause is the inherent difficulty in dealing with the multiple theoretical concepts involved, and the various perspectives and levels of analysis required to explore and understand such collaborations, which comprise heterogenous stakeholders, cultures, perspectives and goals (Albats, 2018). More importantly, the limited amount of studies that exist in this area, do not appear to frame their investigation with compound, established and rigorous learning theories, frameworks or models, that concentrate on the academic learning perspective.

As such, we deduce that there is insufficient evidence on the particular characteristics of *cross-organizational* CoPs, which are integrated, enacted and steered within formal HE. Particularly, research calls for a) thorough investigation and reporting on their design, enactment and outcomes to form an understanding of such partnerships, and b) respective practical implications to inform educators, designers, curriculum developers, practitioners, and policy makers, who seek to employ or participate in such CoP interventions for similar academic-oriented purposes (Ivascu et al., 2016; Perkmann & Walsh, 2007; Probst & Borzillo, 2008).

2.7.1.3 CoPs in Specific Epistemic Domains

Reviews of related empirical work have unpacked several future research directions in the area of CoPs. One of the findings points to a lack of studies that explore the specific "epistemic and discursive practices typical of the communities that make up a social practice" (U. Smith et al., 2017). Such information can evidently support the entry of newcomers and their learning progress in communities within specialized fields (Amin & Roberts, 2008; Pharo et al., 2014). Related work asserts that epistemic disciplines have distinct situated social learning idiosyncrasies that develop through practice (De Moor, 2015; Spagnoletti et al., 2015). This calls for research which is oriented towards informing about the particular *epistemic* structures, meaning-making processes and 'ways of knowing' in CoPs, that can lead to field-specific implications for Cops in HE.

2.7.1.4 Technology Design and Adoption in Blended CoPs

There is an evident lack of research looking at VCoPs (see section 2.3.8), either in blended or online learning environments, with a focus on their technology configuration design (hardware/software). Such evidence is important, particularly when it involves configurations with affordable or free tools, and when it reports on the technology's adoption by CoP members, with an aim to derive respective design and steering guidelines. (Dennen & Burner, 2008; Shneiderman, 2000; Spagnoletti et al., 2015).

It is essential however that these are considered, in conjunction with *pedagogical* and *instructional* perspectives, to fulfill particular *learning* needs, and support certain *social* structures (roles, levels, subgroups etc.) and interactions. Castañeda & Selwyn (2018) suggest that technology-based learning cannot be 'denaturalized' as a phenomenon which is isolated from the *contextual*, *cultural* and *emotional* dimensions of its human capital; these do not only shape its adoption, but also the learning behaviors and outcomes, as well as the identities of those involved. Coinciding with this view, De Moor (2015) emphasized the necessity for targeted sociotechnical mechanisms to guide the design and steering of CoPs, driven by the characteristics of a given domain of interest and social group. Goodyear and Carvalho (2016) shared this view and stressed the "need to understand how a set of tools can be better than another, for a class of users and for a class of tasks". Based on empirical evidence, Novakovich et al. (2017) further clarified that educators should have the right knowledge, criteria and guidance for deciding "the compatibility and relevance of tools", as well as the respective barriers that emerge during their operation in CoPs.

The technology configuration design for CoPs becomes more complex in the case of a cross-organizational model, as it needs to support the *local-to-local* and *local-to-global* interactions of members, who are often *geographically*, *temporally* and *culturally* disperse (De Moor, 2015).

Other studies have yet to report on the implementation of configuration designs that are suitable for *cross-organizational* CoPs embedded in education, making therefore a substantial call for new contributions in this area (Albats, 2018; Pharo et al., 2014).

2.7.1.5 Alternative Theoretical Perspectives of Evaluation

The last two decades saw the employment of CoPs in studies with a predominant focus on *theory verification*. These aimed to empirically identify the characteristics of the CoPs under study, that matched theoretical dimensions from CoP literature. Smith and Shea (2017) discussed these objectives as mostly repetitive, evolving around the "over-researched Wengerian concepts" such as *mutual engagement*, *joint enterprise*, *shared repertoire*), while leaving other important areas untouched.

Wenger (2013) also posited that we are increasingly faced with communities that spread across a vast Landscape of Practices (LoPs), are heterogenous (i.e. multi-disciplinary, cross-organizational), and require deeper and more specialized levels of analysis. As explained in section 2.3.6, LoPs constitute a more recent conceptual extrapolation from the original CoP model and present the need for more targeted investigation in future work.

Additionally, researchers are called to place emphasis on the concepts of *time* and *power*, and examine their impact on the evolution of the practice, learning, and identity (i.e. as members evolve through practice) (Contu, 2014; Cundill et al., 2015; Jackson, 2016). Research on these variables still remains scarce, especially through the lens of *full or* peripheral participation in cross-organizational CoPs.

Drawing upon Boud's and Falchikov's (2006) work, it is also essential that research examines the role of CoPs in the practice of assessment and feedback, which transcends the walls of HE by infusing learning with *authenticity* and mediating critical criteria of real-world scenarios into this (Binkley et al., 2012; Carless & Boud, 2018; Lombardi, 2007).

Finally, studies using more dedicated analytical tools for CoPs, such as the Value Creation framework (see section 2.5.2), are still limited (Booth & Kellogg, 2015). The research community is therefore in need of empirical work which employs such targeted methods to assess and derive credible findings to inform future work on CoPs.

2.7.2 Knowledge Gaps in Creativity Literature

Several gaps in literature have been extracted through the review of creativity-based research in this dissertation. These are discussed in the following sub-sections (see Figure 11).

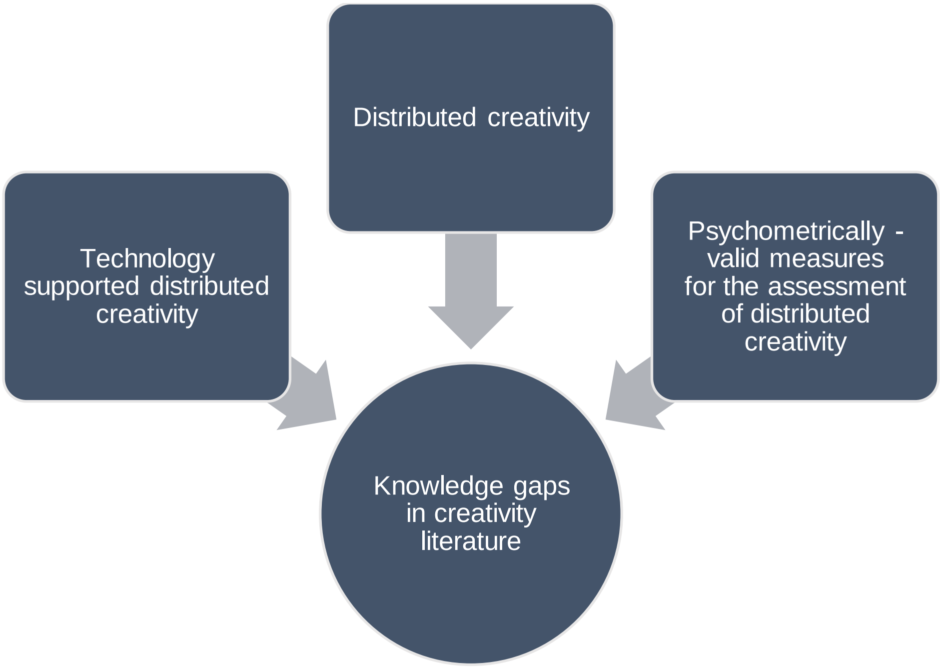


Figure 11: Key knowledge gaps in creativity literature

2.7.2.1 Distributed Creativity Research

As discussed, creativity has been widely investigated in its *individualistic* form, while socially distributed creativity (DC) has only received attention over the past two decades. There is still a notable dearth of work in this area, particularly within educational contexts, due to "forces of authority, control, and constraint that impact creativity in education systems" (Mullen, 2018). Despite clear directions that call for more extensive research in the *collective creative potential*, and the *processes* involving creative *teams* within particular *contexts*, the area still remains largely underexplored (Farh et al., 2010; S. Harvey, 2014; Kurtzberg & Amabile, 2001; P. Paulus, 2001; Yuan & Zhou, 2015).

From a sociocultural educational perspective, Glăveanu's (2014) view of creativity as a "distributed phenomenon, one taking place 'in between' rather than 'inside' the mind", is in full agreement with the SL philosophy which underpins the concept of CoPs and the objectives of this research.

As such, the understanding, fostering and evaluation of *creativity* in learning, the *contextual* dimensions of the *processes*, and the novel *outcomes* that ensue, calls for further focus on DC - particularly through the lens of CoPs – and cannot therefore be ignored (Csikszentmihalyi & Hunter, 2003; Sawyer & DeZutter, 2009).

2.7.2.2 Technology-Supported Distributed Creativity

An additional area in need of further inspection is the technological facilitation and mediation of DC (Herrmann, 2009; S. W.-Y. Lee & Tsai, 2011). Shneiderman et al. (2006) asserted the need for user interfaces that can better support creativity in the effective collaboration, searching, hypothesis formation, alternatives evaluation, rapid discovery and visualization processes; adding that there is "a huge space of research projects that could focus on individuals, groups, products, or processes" as a set of intertwined parts for the development of innovation. A decade later, HCI and computer science efforts still focus on the delivery of *creative systems*, rather than supporting the entire creative processes of the users who interact with these and amongst them (Hoffmann, 2016). Along the same lines, Glăveanu et al. (2019) urged scientists to see creativity in learning, as distributed, situated and integrally mediated through the use of socio-cultural and technological tools. Likewise, current research in HCI calls for a reconceptualization of the human-computer relationships, by reexamining the boundaries between *humans*, *technology* and *context* (physical, social), for the support of 'creative engagement' (Stephanidis et al., 2019).

The above generate directions for research in the evaluation of different technologies and characteristics (systems, tools, interface features) that facilitate DC, and likewise, to benefit from the reporting of the implications of their use in learning contexts, via empirical interventions.

2.7.2.3 Psychometrically-Valid Measures for Distributed Creativity

Contributing to the shift from *task-oriented*, to more *value-oriented* (*experiential*) techniques, is the category of reusable, self-reported or externally scored measures that researchers can use to extract information on specific dimensions of DC (Candy, 2013; Cherry & Latulipe, 2014). However, these have widely focused on individualistic perspectives, examining the 'intra-individual' personality traits, dispositions, inclinations, interests and thinking styles (Crilly & Cardoso, 2017; Gough, 1979; Hennessey, 2017; N. K. Park et al., 2016; Plucker et al., 2004; Runco, 2007; Runco & Mraz, 1992; Torrance, 1966). Consequently, there is a lack of instruments with validated psychometric properties, aimed at the assessment of *collective* forms of *creativity*, within existing research.

It should be noted, that this type of tests has faced criticism and resistance due to a) the stance that there is limited knowledge of what's 'actually being measured', presenting construct-validity issues especially for the case of creativity, based on its blurred theoretical definition (Sawyer, 2011, p. 45), or b) a lack of *consistency* in findings from special testing conditions, involving different *genders*, *culture*, *sample sizes* or *test administration* (K.-H. Kim, 2004; Sawyer, 2011; Swartz, 1988). It is suggested that results from such tests *alone*, may not be conclusive, and should thus be triangulated against scores from additional testing (K. H. Kim, 2006). Most importantly, they should be treated as part of a systemic approach to DC research, which aims to derive an understanding of the interconnected *creative* phenomena – that is - the *people*, the *processes*, and the socio-cultural *context* they transpire in (Glăveanu, 2014; Mayer, 1999, pp. 449–460). Given the above, new directions in research point to the need for *valid* and *reliable* scoring-based tests, as fast and flexible tools that can measure *DC in natural* (i.e. classroom) - rather than lab-based settings. As discussed, combined with other evaluation approaches, these can help derive a better understanding of creativity, as a *dynamic and developmental* - rather than an *isolated* and *de-contextualized* - phenomenon (Glăveanu et al., 2019; Said-Metwaly et al., 2017).

2.8 Summary

This chapter has presented a range of learning theories, concepts and perspectives that were necessary for facilitating a holistic understanding of the work's objectives. As explained, the theory of *CoPs* is extensively described, as it frames the design, enactment and analysis of this research, while creativity, collaboration, authenticity, real-world vocational relevance and identity (trans)formation – facilitated by technology - comprise the target outcomes of the work, in response to its overarching research questions.

Following descriptions of adjacent theoretical viewpoints, it justifies the selection of Situated Learning and importantly, CoPs, for framing this work due to a number of reasons. First, CoPs serve as a new and effective 'paradigm' appropriated to contemporary learning approaches, which is suitable for blended (i.e. versus online-only, as in the case of connectivism) contexts. Second, in line with our work's purpose, *authenticity* has a central role in this, drawing special attention to learning in-situ, rather than traditional classroom-based learning. Third, it sees learning as a *socially co-created* – “rather than a mentalist process” (Fox, 1996), a conception that agrees well with our intervention’s aim to reflect the real-life collective learning processes, transpiring within a diverse pool of personae, skills and competences. Finally, LPP, as a well-articulated construct, answers the inherent objectives of this work to *legitimately* expose novices to the complexities of the authentic landscape of work practices and the actual stakeholders involved.

The chapter also provides a thorough account of *creativity*, as a multi-faceted and complex construct with several conceptualizations and angles of understanding. Further, it draws associations between creativity and CoPs, based on the creativity’s socially and culturally grounded nature.

Finally, findings from the analysis uncover knowledge gaps which help form respective research directions. Specifically, further research in the area of CoPs points to the much-needed governance mechanisms for specific types of CoPs, based on their particular *epistemic*, *social* and *technological* configurations, while also revealing, the lack of evidence on cross-organizational designs. Likewise, the *creativity* field is in need of more contextual or systems orientation to its investigation, with the technologically-supported and socially-distributed form of *creativity* posing as an critical research variable. Additionally, researchers can benefit from valid, reusable and flexible field-based tools that can measure such social and distributed forms of *creativity*.

The next chapter addresses how these findings form respective research directions, are integrated into, and guide this research through an appropriate methodological framework.

3 Research Methodology

The objective of this research is to examine the role of CoPs in facilitating learning to address the gap between the *actual* and industry-*required* skills and qualities of graduates in the HE Design disciplines. The work places emphasis on the development of *creativity* and *collaboration* skills, and qualities that include *real-world vocational relevance* and *professional identity* formation (Jackson, 2016). As these can be attained through a technology-supported, cross-organizational CoP embedded in the HE curriculum, it also aims to report on the design and enactment of its *socio-technico-epistemic* ecology.

In order to evaluate these objectives, the research needs to follow a methodological design which appropriates its context (theoretical underpinnings, aims, sample, practice scenario) and aims. Typically, researchers make such *methodological* judgements based on the research *paradigm*s they follow which associate with a) *ontological* orientations, these being the perceptions about reality (multiple or one single verifiable reality?), b) *epistemological* orientations, defining *what* and *how* people come to know what they know (ways of knowing – what constitutes knowledge, i.e. a belief, a concept, or actual data), and c) the *value system* they abide to, that is, the ethical values and principles that help people interpret what they experience (Patton, 1990) (see Table 1). Consequently, "Methodology is where assumptions about the nature of *reality*, *knowledge*, *values*, and *theory* and *practice* on a given topic come together." (Chilisa & Kawulich, 2012).

Table 1: Key research paradigms, ontological, epistemological, methodological orientations and data collection methods (Chilisa & Kawulich, 2012; J. Creswell, 2014; Guba, 1990; R. B. Johnson & Onwuegbuzie, 2004)

Paradigm	Ontological orientation	Epistemological orientation	Methodology	Data collection methods
Positivism Realism	Single reality	Objective, generalizable, valid	Quantitative, experimental/quasi experimental, survey, correlational/comparative	Questionnaires, experiments, score-based tests, observation, artifacts
Post-positivism	Single reality exists in the world	Deterministic, yet subject to error		
Constructivism Relativism Interpretivism	Many socially constructed realities	Subjective, deeper (vertical) data	Qualitative, phenomenology, grounded theory	Interviews, focus groups, observation, artifacts

Humanism Hermeneutics Postmodernism				
Transformative Indigenous, Postcolonial	Multiple realities constructed, oriented towards diverse & marginalized groups, with politically intertwined meanings	Dialectical understanding aimed at critical praxis	Action research, quantitative, qualitative	Questionnaires, experiments, score-based tests, observation, interviews, focus groups, artifacts
Pragmatic	Not committed to any one system of philosophy and reality	Focus on the research problem in social science research	Mixed methods	Quantitative, Qualitative

Two of the most dominant *paradigmatic* orientations include: a) the *positivist / postpositivist* paradigm, which commonly subscribes to scientific evidence, employing 'deterministic' investigations of the '*absolute truth'* that exists outside the mind. This can be objectively measured or validated through quantitative methods which aim to reduce information into categories or inferences (J. W. Creswell, 2012). *Postpositivism* is roughly speaking, a reconceptualization of *positivism*, that includes the dimension of probability, instead of absolute certainty in research, and b) the *constructivist/interpretivist/relativist* paradigm, which follows a subjective philosophical orientation and subscribes to the notion of multiple realities, acknowledging that interpretations are situated in the personal, historical and cultural biases of researchers and participants.

Although an 'in-between' paradigmatic position was deemed unfeasible and unreliable (Guba, 1990; Guba & Lincoln, 2001), the *objectives of this work* fall in the middle of a *positivist/post-positivist* and *constructivist* continuum, as it aims to extract both a) *objective* (quantitative) results, through what it considers as the scaled and measurable dimensions and effects of learning (i.e. attitudes, facts, events, outcomes) to reduce information, uncover trends, and make comparisons between different variables, as well as b) derive deep, *experience-driven* understandings, originating from qualitative data and *reflexive* analysis (i.e. semi-structured interviews, observations). *Reflexivity* in qualitative research terms, denotes the critical reflection on the knowledge produced, as well as the subjective role of the researcher in this (Braun & Clarke, 2013). This aims to uncover new or reactive evidence, to generate insights, or confirm, explain and expand other (i.e. quantitative) findings, to produce richer inferences across multiple perspectives, levels and times (Chilisa & Kawulich, 2012; J. W. Creswell, 2012; Liamputtong, 2019).

Wenger & Trayner (2019), asserted that researchers still "struggle with boundaries arising from commitments to different methods and paradigms". They described these boundaries as the disparity in a) the perceptions of *truth* or *knowledge* (ontology, epistemology), b) the collection and integration of different data – quantitative/qualitative (methods), c) the externalizations of the lived experiences of those involved, and d) the management of the distance between participants and researchers, in terms of ethics. They added that social situated learning theory falls within a blended realm of paradigms, whose disparities can be bridged only through the lens of a specific theory (such as CoPs). This reflects a choice of the primary methodological focus which relies on the best possible analysis of learning, rather than blind obedience toward a single (ontological or epistemological) philosophy. In related work, as prominent CoP theorists, they offered the Value Creation (VC) framework (see section 2.5.2), as a methodological (analytical) tool, specifically targeted at measuring the worth of learning in CoPs (B. Wenger-Trayner et al., 2019). In fact, they assert that the VC framework is an integrative approach, which poses as an alternative to the strict methodological groundings, offering researchers a shared language for holistic interpretations of CoP-based learning phenomena. Such integrative practices fall within the realm of a mixed methods methodology, which is described next.

3.1 Mixed Methods

This work employs a *mixed methods* (MM) (Creswell & Clark, 2011) research design, by conducting qualitative and quantitative data collection and analyses, to achieve quality and transferability of findings (Teddlie & Tashakkori, 2009).

Johnson and Onwuegbuzie (2004) referred to MM as an "expansive and creative" - rather than constraining - form of research, which employs multiple tactics to triangulate, supplement and augment the research inferences, as well as support or contrast ensuing research cycles. Likewise Creswell & Clarke (2011) suggested that researchers’ current needs entail a high degree of complexity, which should be addressed going beyond mere numbers or words, towards a more integrated and multifaceted analysis. Creswell (2014) saw MM as a *new methodology* which combines the two data genres (quantitative/qualitative), mostly at the analysis and interpretation stages.

MM follows exploratory and confirmatory approaches, through inductive and deductive forms of logic, across various research cycles, if necessary (Teddlie & Tashakkori, 2009). Johnson & Onwuegbuzie (2004) added that MM is pragmatic enough to “describe and develop techniques that are closer to what researchers actually use in practice.” In this regard, MM is sometimes described as a modern-day research paradigm in itself, grounded in the combinational strength of positivist and constructivist orientations, to counteract the limitations of each one in isolation (Denscombe, 2008). Its advantages lie in - but are not confined to - the blend of methods that can back research by ensuring objectivity and generalizability, yet also pay attention to the *truth*, as part of a richer, more vertical orientation to the phenomena under investigation (Lincoln & Guba, 1985).

3.1.1 Appropriateness of Mixed Methods for CoP research

Drawing on VC-based analysis, the authors of the framework (B. Wenger-Trayner et al., 2019) suggested that the theory of social Situated Learning, falls closely with the orientations of pragmatic and constructivist research paradigms, since they primarily both conceptualize knowledge as strongly entrenched in the engagement with the social world; that is, a situated form of knowledge. Like social learning theory, these paradigms are oriented towards the research problem - as a socio-cultural phenomenon – and employ the most appropriate means to explain this, rather than committing to predefined methods for its investigation. Pragmatism, in particular seeks to examine the ‘truth’, and uses diverse procedures and methods to generate its understanding. This use of “pluralistic approaches to derive knowledge about the problem” (J. Creswell, 2014) is best associated with a MM research design. Likewise, as Wenger and Trayner (2019) confirmed, the needs for the analysis of CoP-based learning fit well with an MM orientation, drawing fluidly upon ‘boundary’ information (quantitative and qualitative), an approach which appropriates the theoretical CoP conceptualizations. They explained the significance of quantitative data in providing the opportunity to examine the effects of CoPs through comparison and scale “in the aggregate, beyond individual claims or experience” (B. Wenger-Trayner et al., 2019). At the same time, social learning involves humans and thus needs to be examined from the “experiential aspect of meaning making” (Farnsworth et al., 2016) to construct deeper and more rounded understandings. In this regard, the two methods mutually complement and confirm each other. Indeed, empirical evidence on CoP-based research indicates that mixed methods have been prevalent in this field, constituting this methodological choice as an established, well-tested, and thus highly appropriate option for the aims of this work.

3.1.2 Mixed Methods Design Typology

Amongst others, Creswell (2014) provided a classification of MM designs, identifying three main types, alongside more advanced strategies that combine these designs, when required. These were categorized based on their design, data collection, analysis and interpretation approaches. The three main types include: a) the *Convergent Parallel* design, according to which researchers collect and analyze quantitative and qualitative data concurrently and separately, and then compare these (usually in the discussion) to confirm or disprove findings (a side-by-side approach). It also relies on the premise that the collected data concern the same or similar variables, captured through different forms of information, b) the *Explanatory Sequential* design, which comprises two distinct phases; firstly quantitative data is collected and analyzed. This then informs and guides the second phase with evidence concerning the selection of participants (purposeful sampling from the same pool of participants), and the types of qualitative questions to be asked. The findings are then merged and examined in the discussion section, with an emphasis on how the qualitative explain the quantitative data, c) the *Exploratory Sequential* design, which also involves two distinct cycles of collection, occurring in reverse order to the *Explanatory Sequential* design; that is, qualitative data is first gathered and explored to derive codes, themes and concepts that can inform the second cycle. For instance, this may include experts’ qualitative input for the development of a measurement tool (instrument) in phase one, and administration to a wider sample in phase two, with an aim to generalize findings to the population of interest. Results are then interpreted (in the same order) in the discussion section, by avoiding comparisons, since the two cycles concern different samples.

Consequently more complex approaches integrate elements from the abovementioned three designs to appropriate the specific nature and objectives of the research (Creswell & Clark, 2011). Three more integrative designs include the a) *Embedded/nested design*, which may involve simultaneous (during - convergent) or sequential (pre-post) data collection and analysis (quantitative or qualitative), with one type of data being the *primary* data while the other has a supportive role (primary), b) the *Transformative* design which may also incorporate elements from the convergent or sequential approaches, particularly “within a social justice framework to help a marginalized group” (J. Creswell, 2014) and c) the *Multiphase* design, typically employed in longitudinal contexts, allowing researchers to engage in multiple phases of *convergent*, *sequential*, or *single-method* data collection and analysis, guided by an overarching research objective across time.

3.1.3 The Multiphase Mixed Methods Design in This Work

This research employs a Multiphase Design (MFD), through the formulation of a series of *convergent parallel* and *explanatory sequential* designs, that a) collect and analyse quantitative and qualitative data simultaneously and uniformly, or prioritize one over the other, or employ a single data-type collection, depending on the study requirements, and b) inform the research questions that lead into the following cycles (see Figure 12). The studies in these cycles evolve across three broad sequential phases, namely, the *Design & Implementation*, *Evaluation*, and *Integration* phases.

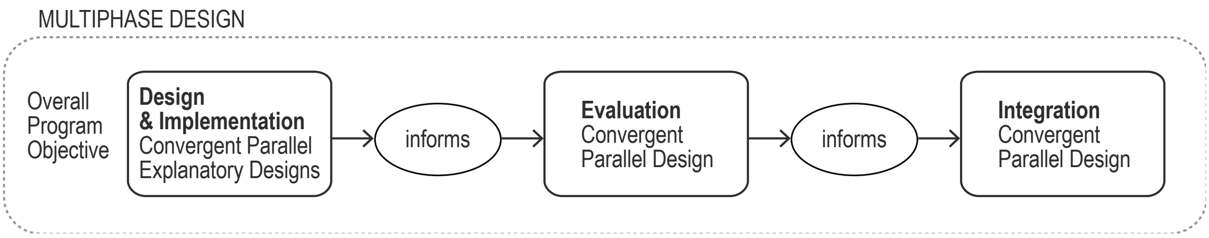
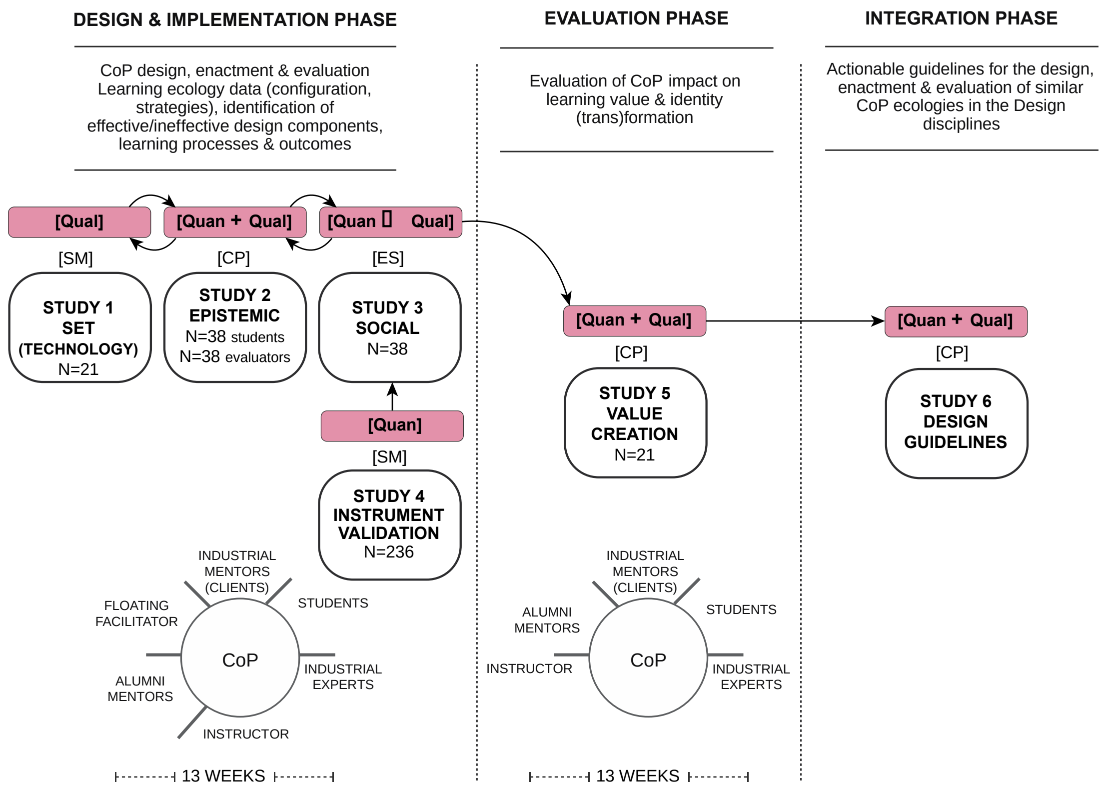


Figure 12: Three-phase mixed-method research design

The complete body of data collection in this dissertation spanned two academic semesters (26 weeks), and the three above-mentioned phases comprised various studies, guided by specific objectives, investigating interconnected variables (i.e. technology, social context, epistemic cognition, creativity processes and outcomes, learning value, identity) of learning. Additionally, the studies which comprise this research, share some overlap across these three phases. For instance, while studies 1-4 are primarily regarded as part of the *Design & Implementation* phase, they also incorporate evaluative parts, the sum of which contribute to the *Evaluation* phase (**2**) of the research (see Figure 13).



*CP=Convergent parallel design - ES=Explanatory sequential design - SM-Single method

Figure 13: Multiphase design notation based on Creswell (2014), individual studies, and CoP stakeholders

The *Evaluation* phase (**2**) thus includes a compound study that employs the *Value Creation* framework (see section 2.5.2) to assess the overall value of learning, drawing from studies in phases **1** and **2**. Likewise, the *Integration* phase (**3**), derives design implications for similar CoP interventions through a critical appraisal of the studies' findings (phase **1**), and most importantly, those extracted through the *Evaluation* phase (**2**). In this way each phase accumulates findings from the previous one to attain its objectives. The following diagram presents a MFD and a multi-study research design, by explaining the distinct phases, participants, studies and data collection methods, using diagramming and notation conventions, as proposed by Creswell (2014).

3.2 Research Design

This section refers to the phases of the research design, namely, the *Design & Implementation*, *Evaluation* and *Integration* phases. The *Design & Implementation* phase (1) informs about the *design* and *enactment* of the cross-organizational CoP ecology, presenting the specific procedures, strategies, and configurations employed, and identifying the effective and ineffective design components. It specifically places emphasis on the *technology configuration* that supports the CoP-based learning, it investigates the learners' *collaborative* processes, and examines their *epistemic* and *creative* outcomes. The *Evaluation* phase (2) assesses the overall impact of the ecology in terms of the *learning value* and the learners' *negotiated identities* through participation in the CoP. Aggregating from the two, the *Integration* phase (3) concludes with a set of practical *guidelines*, as actionable data for designers, researchers and practitioners who seek to integrate similar ecologies into their learning environments.

This work employs the ACAD framework (see section 2.5.1) to guide its top-level *horizontal* analysis, attending to the *epistemic*, *social*, and *technology* dimensions of learning (activities, outcomes), and the Value Creation framework (see section 2.5.2), as a *vertical* approach to the analysis, targeted to the worth of learning (see Figure 14).

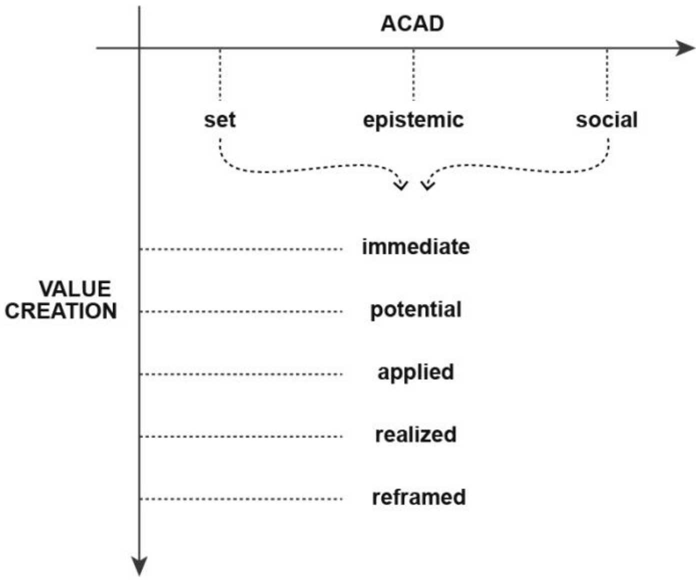


Figure 14: A horizontal (ACAD) and a vertical (VC) approaches to analysis

3.2.1 Research Questions

The MF design for this research is multi-layered, based on a set of broad (phases) and targeted (study) goals (see Figure 15). Each phase has a primary research objective which encapsulates the specific questions of the studies in this work.

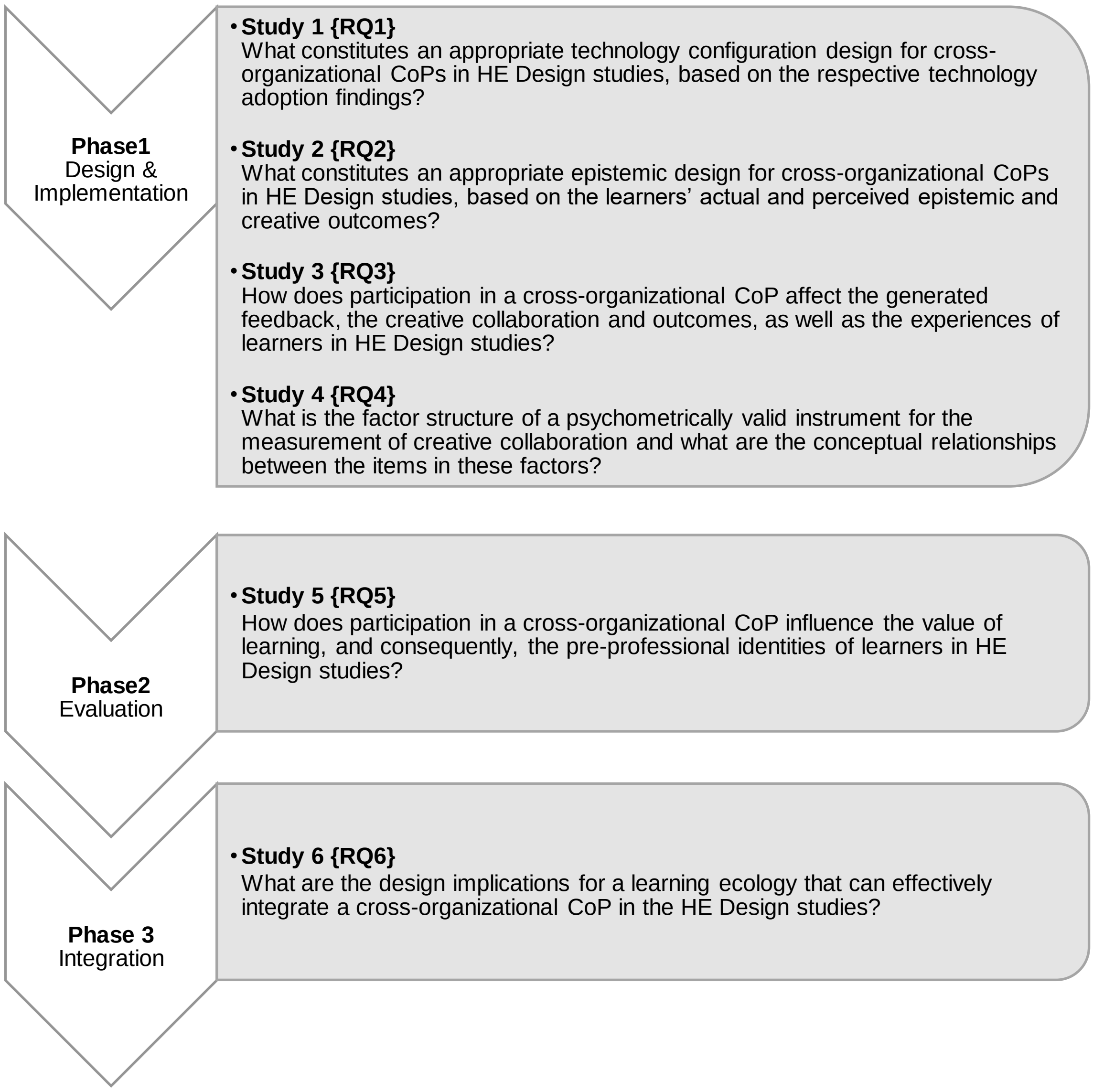


Figure 15: Phases, individual studies and research questions

3.2.1.1 Phase 1: Design and Implementation

Primary research objective: To inform about the *technological, social and epistemic design and enactment of a cross-organizational CoP ecology* which is appropriate for the Design disciplines in Higher Education. This phase consists of four studies:

1) Study **1** presents the cross-organizational CoP ecology, with a focus on the *technology configuration* (see section 2.3.8), which is appropriate for facilitating the activities of learners in the Design disciplines in HE. It also describes the type and level of *technology adoption* by learners, as participants of the CoP (providing a learner's perspective).
2) Study **2** compares two groups (control/experimental) and investigates the impact of the learners' participation in a cross-organizational CoP, on their *knowledge* gains, *creative* outcomes and *epistemic cognition*.
3) Study **3** explores the learners' – as CoP members - perceived *creative collaboration* and their actual *creative outcomes*, as well as the *nature* and *effects* of feedback from industrial CoP members on their learning experiences.
4) Study **4**, is a supporting sub-study to study 3, which adopts, investigates and reports on the *validation* of the psychometric properties of the ASCC (see 3.2.9.5), an instrument that was used to measure learners' perceptions of their creative collaboration processes in the blended learning setting.

3.2.1.2 Phase 2: Evaluation

Primary research objective: *To evaluate the impact of cross-organizational CoP participation on the learning value and the development of learners' pre-professional identities.*

Study **5** gathers findings from all previous studies, alongside new and more comprehensive evidence (collected in semester 2) concerning the learning value that was created through CoP participation. In doing so, it also draws inferences as to the transformation of the learners' *identities* into their pre-professional statuses.

3.2.1.3 Phase 3: Integration

Primary research objective: *To provide actionable guidelines for the design, implementation, facilitation and evaluation of cross-organizational CoPs in the HE Design curriculum*.

Study **6** constitutes a conclusive part of the research, since it derives a set of heuristics aimed to help researchers, educational technologists, instructors and practitioners alike in the design, implementation and evaluation of similar CoP ecologies in the HE Design studies.

3.2.2 Participants

This research involved a group of 38 third-year university students at the Multimedia and Graphic Arts department of the Cyprus University of Technology, who were enrolled in the Web Design and Development modules 1 and 2 (WDD-1, semester 1, WDD-2, semester 2) Although students were divided by registration into the Multimedia (experimental - G1, N=21) and Graphics (control - G2, N=17) groups, they shared a common program structure and syllabi during the first two years of their studies. Having followed the same program structure and syllabi, they had access to the same prior subject-level information. Their GPAs also fell very close together (see Table 2).

Table 2: Comparison of experimental and control group GPAs

	Group	N	Mean	SD	F	Sig.	t	df	P
GPA	**Experimental (G1)**	21	7.279	.912	1.892	.178	-.074	36	.941
	Control (G2)	16*	7.260	.565					

* Unavailable grade information for one participant

In both group conditions, students self-formed teams of approximately four-to-five people each, which is evidently a good number for sufficient individual accountability, and good unity prospects within the team (Barkley et al., 2014; D. W. Johnson et al., 2000). Such teams, as CoP subgroups, are commonly associated with projects. They are oriented towards the creation of targeted knowledge and the development and dissemination of outcomes, which are perceived as their contributions to the community (E. Wenger et al., 2009).

As mentioned, the teams were neither randomly, nor purposefully formed (i.e. by the instructor). Although the challenges of team formation are widely discussed in literature (Alberola et al., 2016; Bacon et al., 2001; Tereshchenko et al., 2019), evidence indicated that instructor-led team formation is not usually favored by students, and doesn't bear significant effects on their learning outcomes either (Pociask et al., 2017). Further, instructor field notes from this research indicated that with the exception of one team, the rest of the teams were quite diverse in terms of skills and attainment levels (based on previous teaching data).

Consequently the participant involvement across the studies of this research is as follows (see Table 3):

- Study **1** involved 21 students from the experimental group (G1) only
- Studies **2** and **3** involved a total of 38 students from both experimental and control groups, as part of a quasi-experimental between-subjects design
- Study **4** involved 236 undergraduate/postgraduate students from local and overseas universities with experience on collaborative projects in blended or online learning settings.
- Study **5** involved 21 students from the experimental group (G1) who advanced to WDD-2 (semester 2), a consecutive course to WDD-1.
- Study **6** drew upon findings from all the previous studies without any further data collection

Table 3: Summary of studies and group participants

Phase	Studies	Participant Groups	Semester
Design & Implementation	Study 1 (Set)	G1 (N=21) students	Semester 1 (WDD-1)
	Study 2 (Epistemic)	G1 (N=21) + G2 (N=17) students + 38 evaluators	
	Study 3 (Social)	G1 (N=21) + G2 (N=17)	
	Sub-study 4 (Validation)	Under/Post-graduate students (N=236)	N/A
Evaluation	Study 5 (Value Creation)	G1 (N=21) students	Semester 2 (WDD-2)

Integration	Study 5 (Design Guidelines)	N/A	N/A

Permission to run the studies was obtained from the department. The appropriateness of the studies' methods were considered and approved by an internal ethics committee. Further, all ethical considerations regarding data collection were addressed in signed consent forms by all stakeholders. The topics concerned confidentiality and privacy (i.e. anonymization of submissions, no-sharing policy), approval for recordings and transcriptions (i.e. focus groups and interviews), data storage and deletion following analysis, as well as the participants' right to opt out at any point in time, and importantly, that participation/non-participation or the information provided did not bear any impact on the students' academic grades. At the end of semester 2, a new consent form was also signed by student participants to provide their group and team chats (having anonymized all logs first).

3.2.3 The Learning Ecology

3.2.3.1 *Course Context: Web Design and Development (WDD)*

The studies in this research evolved in the context of two Web Design and Development (WDD-1, WDD-2) classes, specifically two 3rd-year undergraduate modules. The modules comprised 180-minute weekly lessons, and run for 13 weeks each across two consecutive semesters (total = 26 weeks). Guided by User-Centered-Design (UCD) principles, processes and methods (described in section 3.2.3.2), the modules focused on building fundamental knowledge and competence on front-end web technologies, through the use of HTML, CSS and JavaScript technologies.

The typical epistemic activities of module WDD involved systematic research, ideation, justification / documentation, planning, diagramming, visual prototyping, GUI (graphical user interface) design, development, and administration of server/website environment (Lowe & Eklund, 2002; Shneiderman, 2000).

Aside of theoretical groundings, the classification of these activities originated a) from the instructor's prior teaching knowledge and industry experience in the Design domain and b) through informal discussions with the students involved. Specifically, following an initial walk-through of the lesson goals, students discussed their prospective activities (*orientations* in VCoP terms) with the instructor. This was feasible since students drew from their prior UCD-based knowledge (2nd year). This process was also essential (for the instructor as the CoP administrator) for defining the technologies and tools needed to support these orientations.

3.2.3.2 User-Centered Design (UCD)

User-centered design (UCD) is a science (Norman, 1986) that focuses on the users' goals, needs and limitations, as the primary dimensions of the design process, from project initiation to project completion stages (Baek et al., 2008; Giacomin, 2014). UCD methods are widely adopted in engineering, technology, and importantly Design and development courses (i.e. product design, software development) to design for and elicit information about the relationship of the *user* and a *product* (either hardware or software). They draw conclusions on the *user experience* or the *usability* of systems, using techniques such as interviews, observations and field-notes, questionnaires, software information (i.e. logs, number and analysis of errors, completion times), eye tracking and other physiological measures (Abras et al., 2004; Giacomin, 2014; Lowdermilk, 2013). For the purposes of this study, we adopted certain key activities from Vredenburg et al's. (2002) process model, such as: *user requirements analysis, iterative design, usability evaluation, task analysis, heuristic evaluation, user interviews, prototyping, informal expert reviews,* and *card sorting.*

Based on a combination of the two areas (WDD, UCD), we extracted a customized process model to appropriate the epistemic requirements of the WDD-1 and WDD-2 modules. This comprised organizational, conceptual, presentational, navigational and structural aspects of the design process (Conte et al., 2007). From a practical perspective, it included: a) the translation of business expectations and end-user needs into design and technical requirements, b) analysis and ideation, c) system architecture design, d) layout/GUI design, d) development and implementation, and e) user-experience evaluation. An adaptation of the combined WDD and UCD process models, from Lowe & Eklund's (2002) and Vredenburg et al.'s UCD (2002) models respectively, is outlined in Table 4.

As recommended by the VCoP framework (see section 2.3.8), this adopted model served as the basis for extracting the community's *orientations* through informal discussions with the students (CoP participants), to define the CoP's technology configuration (E. Wenger et al., 2009). These steps can be found in chapter 4.

Table 4: WDD process model based on Lowe & Eklund's (2002) WDD and Vredenburg et al.'s UCD (2002) models

Web Design & Development (WDD) process model: phases and activities	
1. Project planning	**a.** Research & documentation (subject and users)
2. Requirements	**a.** Gathering **b.** Analysis & documentation
3. Project charter / proposal	**a.** Author & document **b.** Publish online **c.** Client feedback
4. Content	**a.** Define needs & document **b.** Provisions / exchange / delivery **c.** Store & share
5. Sitemaps WBS (work-breakdown-structure)	**a.** Card sorting **b.** Create & document **c.** Showcase online **d.** Client feedback **e.** Informal expert evaluation
6. HTA (hierarchical task analysis)	**a.** Test tasks & subtasks **b.** Create & document
7. Time-planning	**a.** Create & document **b.** Publish online **c.** Client feedback
8. Ideation and visualization: wireframes & annotations (low fidelity)	**a.** Iterative design & documentation **b.** Online showcase **c.** Client feedback **d.** Informal expert evaluation & feedback
9. User testing, role-playing, walkthroughs, interviews	
10. High fidelity prototype development	**a.** Iterative design & documentation **b.** Showcase online **c.** Client feedback **d.** Informal expert evaluation & feedback
11. Heuristic evaluation	
12. Development	**a.** UI development **b.** Publish online **c.** Client feedback **d.** Informal expert evaluation & feedback **e.** Formal expert evaluation

In addition, the integration of these phases and activities, as well as the CoP contributions can be seen in Table 5.

Table 5: Lesson plan for students in WWD 1 (semester 1)

Week	Epistemic areas (classroom)	Deliverables	CoP role	Tools - environments
1	Introduction	Assignment briefing		*Internal*: Moodle, Google Drive
2	Introduction to HTML 1	Requirements collection & analysis		*Internal*: Moodle, Google Drive, ConceptBoard
3	Introduction to HTML 2	Extended project brief, time plan (Gantt chart) Website sitemap & HTA	Client review	*Internal*: Moodle, Axure RP, Google Drive, ConceptBoard *CoP-wide*: Behance
4	Images & graphics for the web	Low fidelity wireframes	Client + AM review	
5	CSS (1)	Low fidelity wireframes – revised User testing		*Internal*: Moodle, Adobe Photoshop, Adobe Illustrator, Google Drive, ConceptBoard *CoP-wide*: Behance
6	CSS (2)	High fidelity wireframes	Client + AM review	
7	Workshop (part 1)	High fidelity wireframes - revised		
8	Workshop (part 2)			*Internal*: Moodle, Adobe Photoshop, Adobe Illustrator, Adobe Dreamweaver, FTP repository, Google Drive *CoP-wide*: Hosting server, Hypothesis.is
9	HTML forms			
10	Introduction to Javascript	Web design layout version 1	AM review	
11	Website architecture & administration			
12	Project work reviews	Web design layout version 2 Heuristic evaluation User testing	Client + AM review	
13	Project presentations	Presentation		*CoP-wide*: Hosting server
14	Evaluations		Client, AM, expert evaluations + reviews	Google Forms
15	Exams		Instructor	Co-located

3.2.4 Instructional Context

The weekly sessions employed a problem-based-learning (PBL) approach (see section 2.2.3). Following theoretical PBL guidelines, student teams were presented with a set of ill-structured, 'messy' problems to resolve, without substantial help from the instructor (Boud & Feletti, 1997; De Graaf & Kolmos, 2003). They were however, informed about the distinct phases and the time available for each phase, as part of a resolution process. Specifically, students were prompted to first conduct research individually, in order to understand and evaluate the problem at hand (*evaluation*), and then suggest possible ways of approaching this in their teams (*proposition*). In the next phase, through further research (*research*), the teams should determine the specific (i.e. technical, conceptual) requirements and define the appropriate course of action. Students were also asked to make mini presentations to explain and support their findings and subsequent decisions (*argumentation*) to the rest of the class, and respond (negotiation) to questions or contrasting feedback (criticism). Mini-lectures, quick tips and brief workshops were also delivered by the instructor or the floating facilitator whenever necessary (see Figure 16).

PBL was considered highly appropriate for the social learning approach that incorporated CoPs with internal (students) and external (industrial) members into the curriculum, for a number of reasons. First, students had opportunities to practice in managing real-life problems and respective needs, that were not filtered or curated to match their level and scope of knowledge. This was beneficial for their similar encounters with industrial mentors (clients) in the CoP (experimental group only) who assigned 'ill-structured' tasks to students (see section 3.2.5). Second, they had to exercise responsiveness to *social judgement* (Hennessey, 2017), being urged to argue for and support their design and other decisions, as well as integrate 'messy' or disagreeable feedback from peers into their work during PBL sessions. This prepared them for similar scenarios that emerged due to the diverse group of reviewers in the CoP (experimental group only) (see section 3.2.6). Third, the rapid and rigorous problem-solving procedures of the classroom reflected the nature of the time-restricted practices inherent in real life scenarios (mediated through the CoP), which call for the adept handling of team-based pressures, and the re-organization and coordination of team roles and activities accordingly.

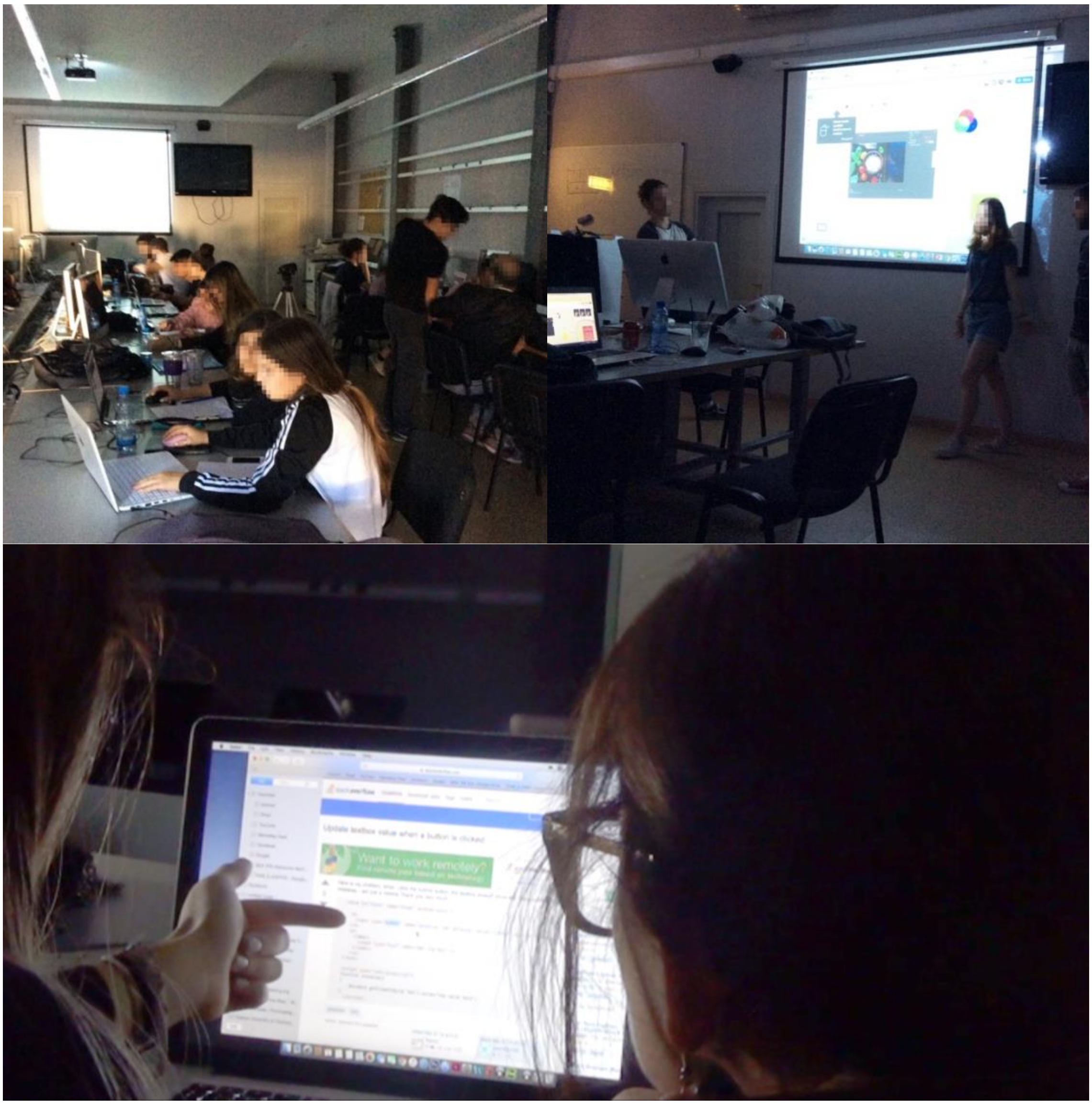


Figure 16: Students collaborating in pairs and teams presenting (in mini crits) as part of PBL class-based activities

Finally, it should be mentioned that the classroom-based tasks and thematic areas of instruction, were designed to coincide thematically with the respective development phases of the teams' projects and the CoP-reviewed deliverables .

3.2.5 Epistemic Design (Control and Experimental Conditions)

A total of five members from the industry assigned project briefs to students in WWD-1, for the design and development of websites based on their specific business needs (see Table 6). Each project was essentially developed twice, once by a team in the experimental group (G1) and once by a (shadow) team in the control group (G2) independently. Both groups shared identical course structure and materials, and both followed a problem-based learning (PBL) instructional approach in class (see section 3.2.4). However, only students from the experimental group participated in the cross-organizational CoP that was supported by specific technology configuration for both formal and informal learning processes (see section 3.2.8). A CoP membership was therefore applicable to students in the experimental condition only. In contrast, students in the control condition engaged only in ordinary university-wide exchanges as part of the traditional curriculum.

In WDD-2 (semester 2), the experimental group (G1) students worked on advancing their assigned projects from semester 1, alongside other module assignments.

Table 6: Experimental and control group teams structure, authentic projects and industrial CoP membership

Project / client domain	Law Consultancy	Non-profit	Sports Management	Property Development	Investment Services	Industrial members	Gender
Team	A	B	C	D	E	Alumni mentors	2 female 1 male
Experimental (CoP) (G1) N=21	4 female	1 female 3 male	4 female	2 female 3 male	3 female 1 male	Industrial experts Industrial mentors (clients)	3 male 3 female 2 male
Control (G2) N=17	4 female	5 female	5 male	3 female	-		

3.2.6 The Social Structure of the Cross-Organizational CoP

The aim of this research was to encourage authentic social learning by exposing learners to the complexities of real-life contexts, through the participation of members from the industry in an education-integrated CoP. It therefore employed an authentic CoP model (Iskanius & Pohjola, 2016), involving *industry* stakeholders with diverse knowledge and experience in the field of Design, who self-willingly joined, to act both as mentors and evaluators for students. These stakeholders tend to be socially and ethically motivated to share expertise and make positive contributions to the local educational bodies. A full account of the incentives behind the different memberships and roles in the CoP is presented in section 3.2.7.

The CoP was planned and steered by the course instructor (as the CoP steward) as suggested by the framework for newly formed VCoPs (E. Wenger, 2009). As such, the community roles included (see Figure 17):

a) The *instructor* of the two modules
b) *Floating facilitator*: a final year teaching assistant, responsible for facilitating team-discussions, directing to information sources and providing technical and generic assistance to teams
c) *Alumni Mentors*: two female and one male, in semester 1, and two female in semester 2, alumni with a minimum industry experience of two years who offered constructive feedback on learners' work deliverables at different project stages. Students had access to brief biographical information for each one, at course initiation.
d) *Industrial Experts*: three male professionals with more than six years of industry experience in high-ranking positions, responsible for the evaluation and feedback on completed projects (websites) at the close of the semester. Although, they had limited interaction in the CoP due to their role in providing summative reviews and evaluations (thereby adopting a transactional level of participation) (Lave & Wenger, 1999b), their prospective role was intentionally communicated to students at the start of the semester, as it was expected to steer student motivation and commitment towards their final outcomes. They were also accessible to students via a common social networking group (on Facebook) at the start of semester 1.
e) *Industrial mentors* (clients): two female and three male representatives of five local organizations who assigned students the authentic projects (see section 3.2.5) and provided resources and regular feedback on their deliverables. A brief history of the organizations' operations, goals and work were made available to students at project initiation.

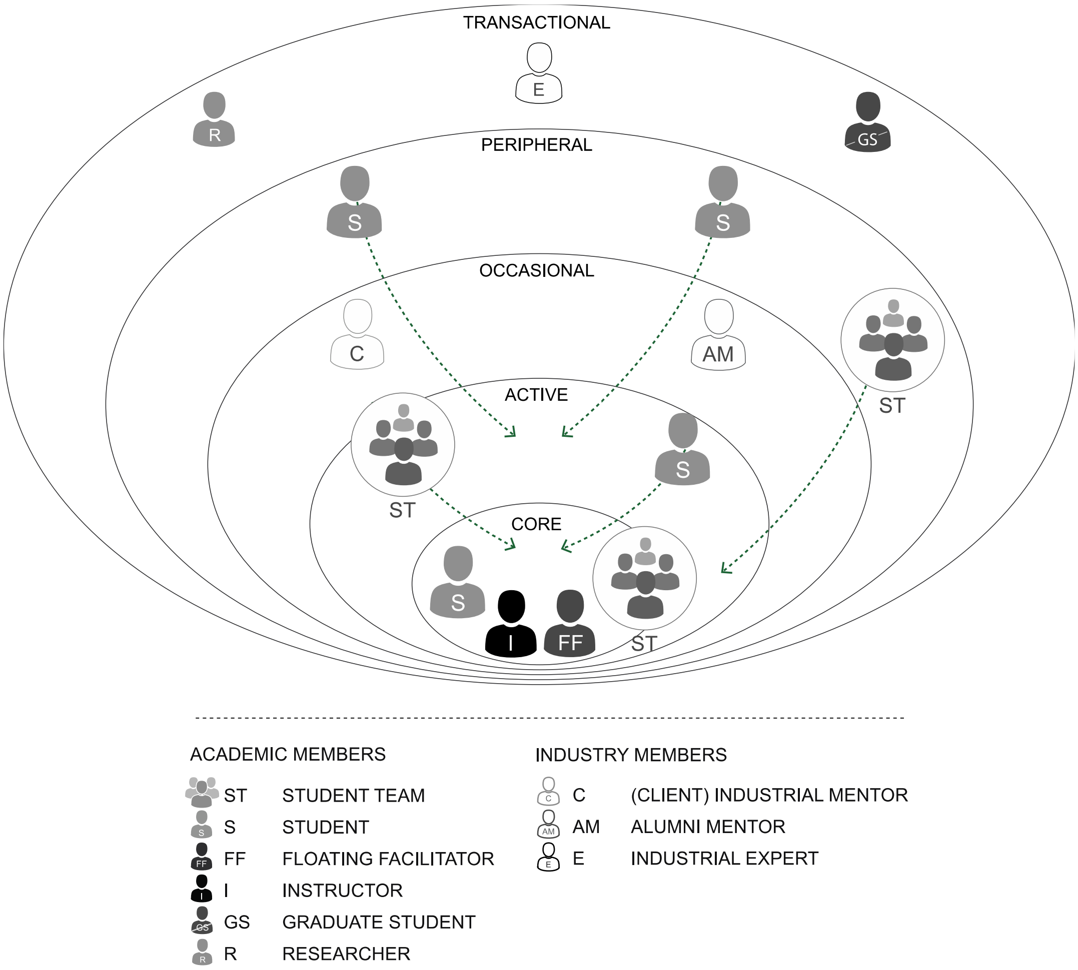


Figure 17: Cross-organizational CoP social structure and levels of participation (semester 1) based on Wenger-Trayner's (2011) model in Figure 5

The following stakeholders participated in CoP activities on only one occasion, for the purposes of evaluation (see chapters 5 and 6), in order to extend the assessing/evaluation sample and ensure sufficient diversity and objectivity in the results. They therefore adopted a *transactional* role and did not constitute representative members of the CoP. Specifically, the evaluator group involved:

f) *Graduate students* (N=24): 16 female and 8 male students as experienced members of the CoP, who were asked to provide evaluations for the final websites of both the experimental (G1) and control (G2) groups
g) *HCI experts*: two male and two female HCI researchers, who were asked to provide expert evaluations of the final websites

Following data collection and analysis from phase 1 and based on the instructional design of the WWD-2 module, the social CoP model was adjusted in phase 2 (see Figure 18).

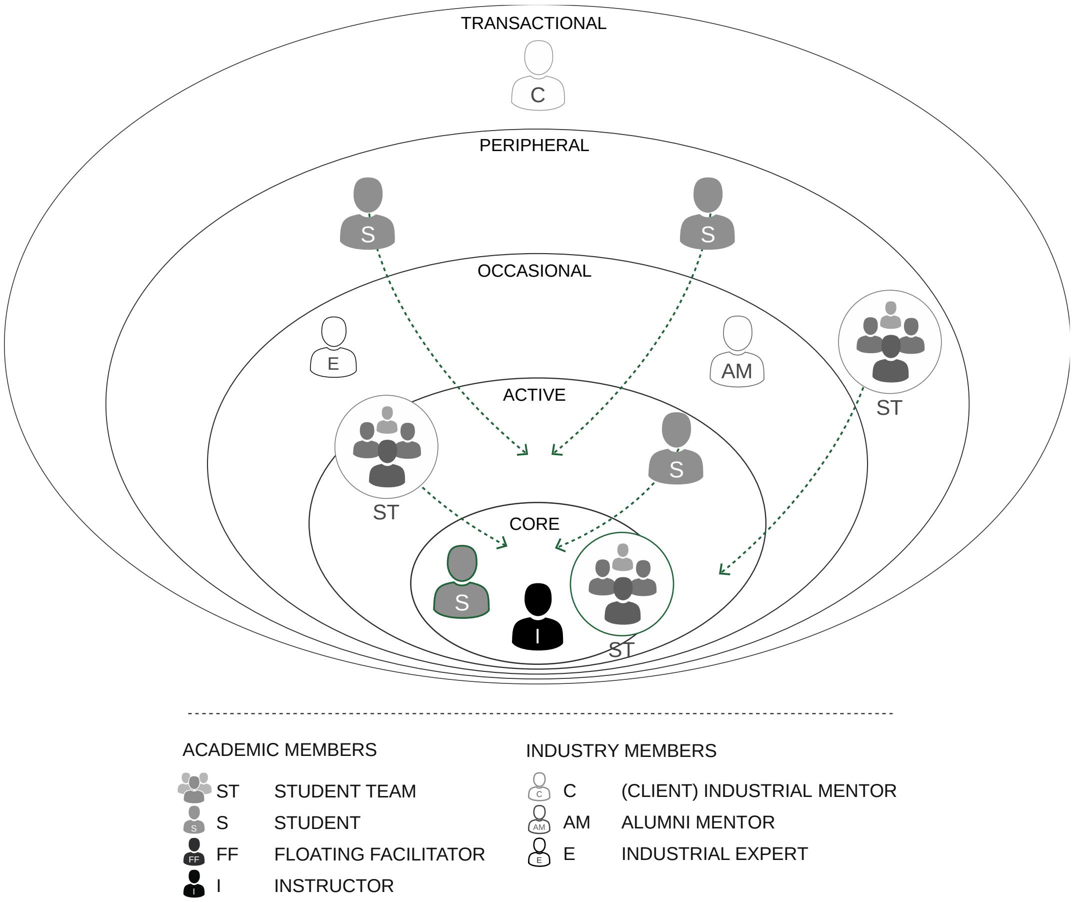


Figure 18: Community of Practice: social structure and levels of participation (semester 2) based on (Wenger-Trayner 2011)

Specifically, students deemed the role of industrial experts as significant and requested more substantial and *face-to-face* interaction with them early on in the semester. For this reason, aside of the existing members (faculty, students, alumni mentors, industrial mentors) the CoP model in semester 2 involved five new industrial experts, who were invited to give (online/offline) talks and workshops every two-weeks (see Figure 19). The talks emphasized their own university-industry transitions, the challenges they encountered and how these were addressed, as well as their professional insights and advice regarding the status and the criteria for success in the local and international

Design industries. They also evaluated students through one-to-one (video-conferenced) mock-job interviews, as a partial contribution to their academic assessment at the end of semester 2. The alumni mentors' involvement was also shifted to the peripheral level due to the heavier involvement of experts. Additionally, based on informal discussion with students, it was decided that the role of the floating facilitator would not be required in semester 2.

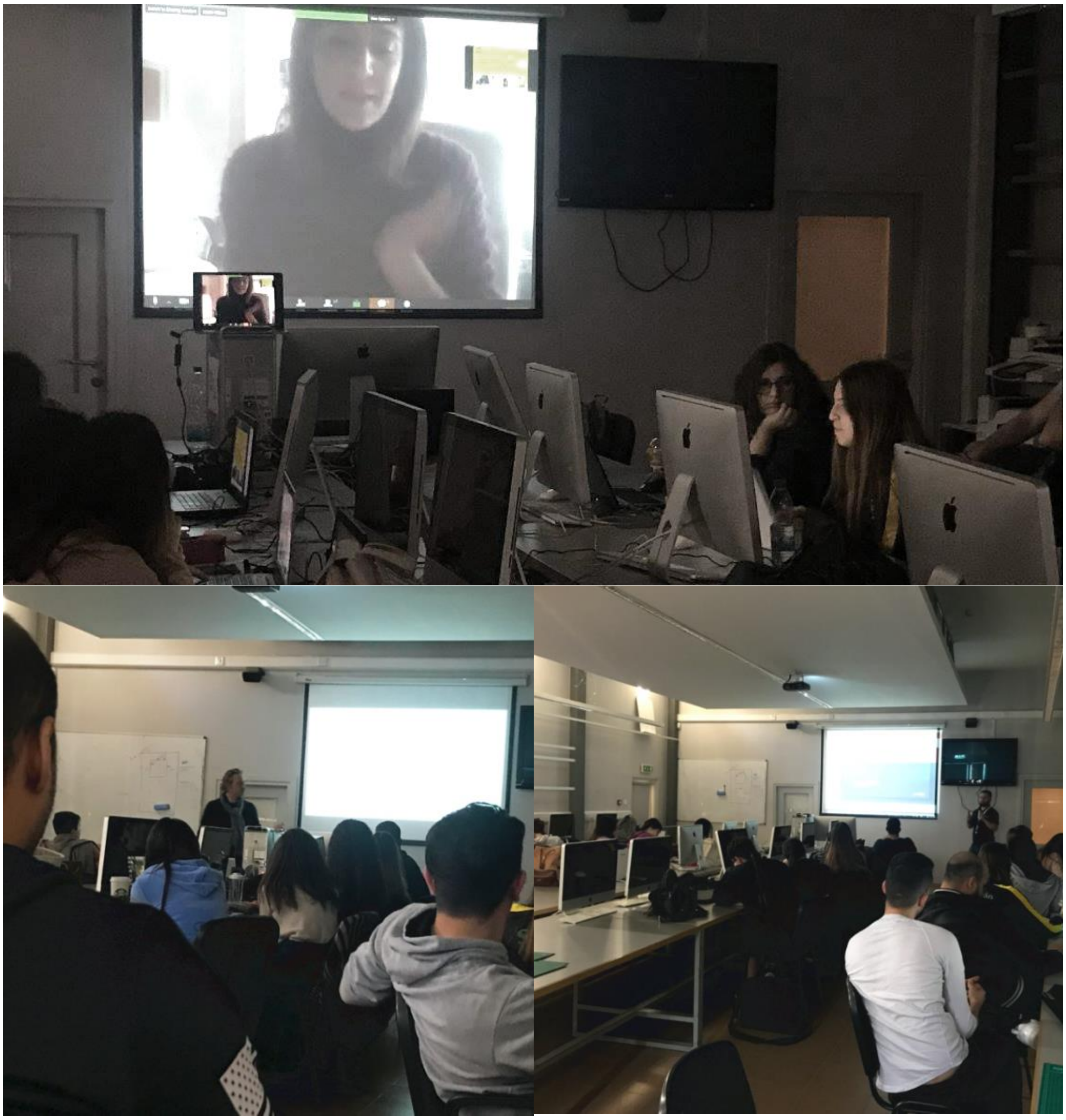


Figure 19: Industrial experts talks and workshops (semester 2)

Drawing from the 'levels of participation' model (see Figure 5), **Table 7** presents the rationale behind the 'positioning' decisions for each CoP member. It should be noted that while the cross-organizational CoP was designed based on the idea that different roles would enter specific 'circles' of participation (i.e. active, occasional peripheral) depending on their *interests*, *input* and *availability* (i.e. external members), it was also anticipated that the boundaries of these circles would be fluid. In fact, the CoP theory foresees this prospect, since as the topics of interest and attention and the meaning-negotiation processes in the community shift over time, members enter and exit its various 'circles' accordingly (Boylan, 2010; Farnsworth et al., 2016). This engagement/disengagement pattern indicates a healthy type of movement and supports a feeling of legitimacy, regardless of the participation level of different members in the CoP.

Table 7. Cross-organizational CoP members, levels of participation decision rationale

	Members	Levels of participation	References from CoP theory supporting the rationale of member participation levels*
1	Instructor/coordinator Floating Facilitator Student Teams or Students	Core group	CoP leadership, active engagement in discussions, community steering, projects involvement. Members become auxiliaries to the CoP coordinator over time Community portion: 10-15%
2	Student Teams Students	Active group	Meetings attendance, occasional participation in CoP forum (i.e. social network), without the regularity and intensity of the core group Community portion: 15-20%
3	Alumni Mentors Clients	Occasional group	Participation only based on a topic of interest, some contributive action to the community, or project involvement
4	Student Teams Students	Peripheral group	Sustained connection to the community, but less engagement and authority. Observations of core and active members' interactions help gain own insights. Semi-private, one-to-one interactions keep the peripheral members connected. Community portion: large
5	Industrial Experts Graduate Students Researchers	Transactional group	Outsiders' (non-members) occasional interaction with the community, to receive or provide a service or gain access to community artifacts (i.e. publications, website, tools, resources)

* Sources: (Farnsworth et al., 2016; E. Wenger et al., 2002a; Wenger-Trayner, 2011)

3.2.7 Social Human Capital Incentives

An overall key objective of this research was the involvement of industrial (expert) members in a curriculum-integrated CoP. Based on their heavy work-life schedules, this was expected to be challenging. Being key stakeholders in the CoP's cross-organizational and multi-competence structure, it is therefore necessary to explain their membership incentives, as well as provide (partial) evidence of this work's *dependability* and *transferability* criteria. We describe these for each external member role independently below.

- **Facilitators** (teaching assistants) may be graduate students in the same department who can support, both class-based and online learning processes. Voluntary participation is often expressed by students who present a sound interest in advancing their knowledge and expertise in the field, especially in light of their forthcoming industry transitions
- **Alumni mentors** are graduates of the same department/school with an intrinsic interest in the particular field of interest. Driven by ethical motives, they often show willingness to give back to the university by helping others on similar trajectories (E. Wenger, 2010c). They typically wish to maintain good social ties with their department/university, based on their relatively recent ties with the academic sphere (temporal and relational proximity). Such "expressions of loyalty" (McAlexander & Koenig, 2001) are typically representative of alumni with positive academic experiences (J. Pearson, 1999). Further, their involvement can also be perceived as an asset for their early-career resumes.
- **Industrial experts** as professionals in the field, they are motivated by the opportunity to 'have a say' in education, especially when this concerns new learning directions, methods, tools and assessment criteria, thus establishing an open channel of communication with the university. Additionally, their involvement in student projects can serve as an opportunity to draw from a filtered talent pool for future recruitment purposes.
- **Industrial mentors (clients)** as local businesses/organizations, are usually keen to receive assistance in developing early ideas, prototypes and 'proofs-of-concept' for pending or prospective (experimental) projects. The students' contribution (without pay) is of value in this case, due to these stakeholders'

likely focus on other priorities (i.e. running projects) and their heavy schedules, as well as the possible lack of available resources (in terms of budget, time and human capital) to implement such initiatives/projects.

3.2.8 Cross-Organizational Technology Configuration: the Set

According to the ACAD framework (see section 2.5.1), a key component of learning networks and communities is the *set*, representing the *physical*, *digital* or *blended* setup which hosts and supports the social learning activities (Carvalho & Goodyear, 2014a). While the physical context may be important in the analysis of co-located learning, this work places particular emphasis on the understanding of CoP-based learning and practice (i.e. interaction, communication, collaboration, feedback), which was largely facilitated and operationalized through a targeted technology configuration (collection of platforms, tools and features).

Wenger et al (2009) offered the term ‘steward’ for people who take on the role to assist their community in selecting, configuring and using technology to appropriate their practice. They also suggested that the technology configuration strategy originates from five streams of *stewarding activities,* namely, community understanding (knowledge of the members’ and their practice needs), technology awareness (knowledge of available and relevant technologies), selection and installation (including technical aspects of implementation), adoption and transition (facilitating the learning and use of technology), and everyday use (observing, inventing, enhancing and evolving the technology to match the needs of the practice).

Based on the cross-organizational nature of the CoP, this work’s strategy for its technology configuration was driven by both *intra* and *cross-organizational* objectives such as, tool *availability* (i.e. free/low-cost/subscription-based), *appropriateness* and *efficiency* for the epistemic (WDD) practice *orientations* (see section 2.3.8), and *familiarity* with tools, based on the members’ level of experience with these (i.e. tools already adopted by the organic community), and their ease-of-use (i.e. common, conventional functionality). Extensive reporting on the activities for the CoP’s technology configuration setup and stewarding can be found in chapter 4 (study 1).

The resulting technology inventory, comprising the platforms, tools, features, context, and WDD activities is presented in Table 17. The technology items in this have been classified as ‘team-based’, ‘community-wide’, and ‘single-user’, as well as online/offline, and synchronous/asynchronous contexts. These are described next.

3.2.8.1 Team Context Technologies

- Google Drive & Google Docs (“Google Drive - Cloud Storage & File Backup for Photos, Docs & More,” n.d.) were used for document management and sharing.

ConceptBoard (“Conceptboard - Virtual Collaboration Workplace for Teams,” n.d.), is a shared whiteboard/canvas, used in real-time team practices (see Figure 20). Specifically, the interactive canvas facilitated real-time collaboration, brainstorming, card-sorting, experimentation, resource storage, and artifact creation. It also allowed for synchronous/asynchronous communication, through live chat, stickies, video-conferencing, and screen-sharing.

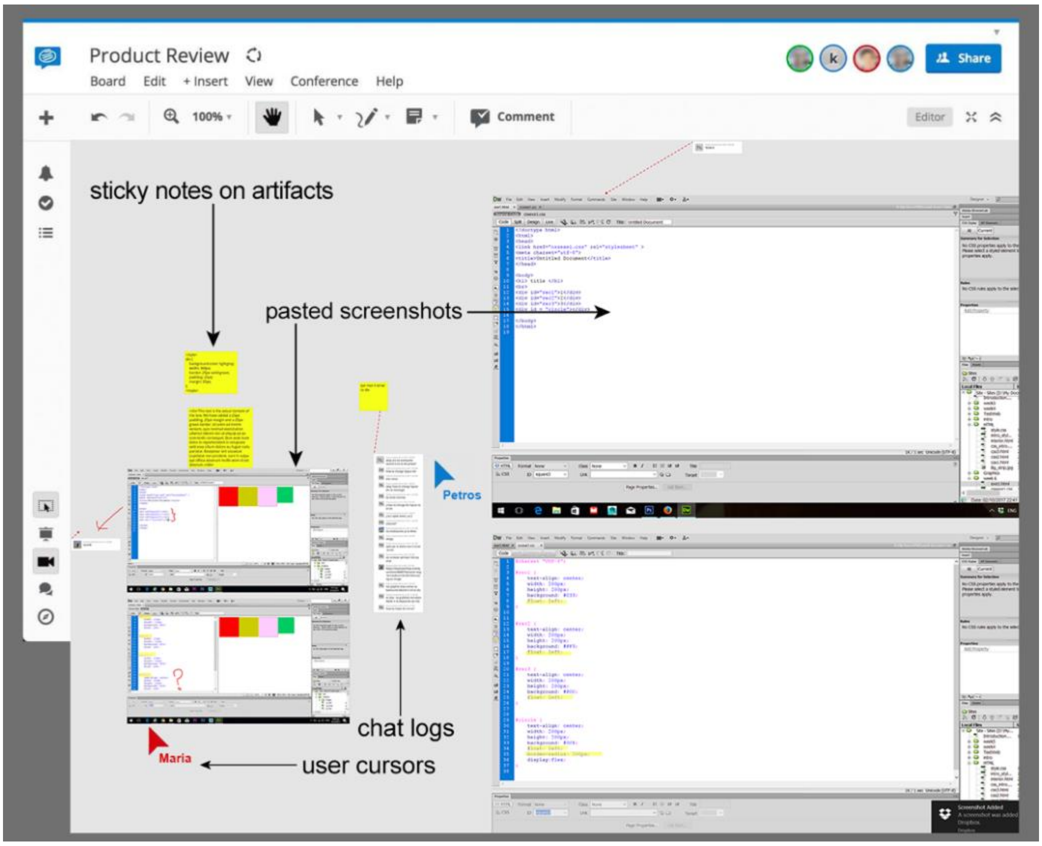


Figure 20: Conceptboard team canvas during PBL class-based activities

- Adobe Dreamweaver (Version 12, 2012) (*Adobe Dreamweaver CC | WWD*, n.d.), was used as the web development software (code/WISWIG editors) and a File Transfer (FTP) tool for online sharing and publishing, utilizing a built-in version control system (VCS). This allows different users to work independently and upload work by merging their changes, on a central server directory. It also allows for tracking (version history) and reverting to various versions.

3.2.8.2 Community Context Technologies

- Behance (*Behance*, n.d.), is an online visual work promotion (portfolio) and social networking platform, allowing the upload and management of various types of media, as well as providing an integrated forum for reviews on every media page. The platform was used by student teams, to upload website prototypes at certain project stages, and by alumni and industrial mentors, in order to post their reviews and feedback (see Figure 21).
- Hypothes.is (*Hypothesis – The Internet, Peer Reviewed.*, n.d.) is a real-time webpage-integrated annotation tool, used by alumni and industrial mentors to insert reviews on various webpage elements during the web-development stage in the project cycle.
- Moodle ("Moodle - Open-source learning platform | Moodle.org," n.d.), is an LMS that was used by the instructor and students to access course material (i.e. lesson plans, lecture notes, assignments).
- A Facebook group was used for day-to-day public (timeline) and private (chat) communication between the CoP members

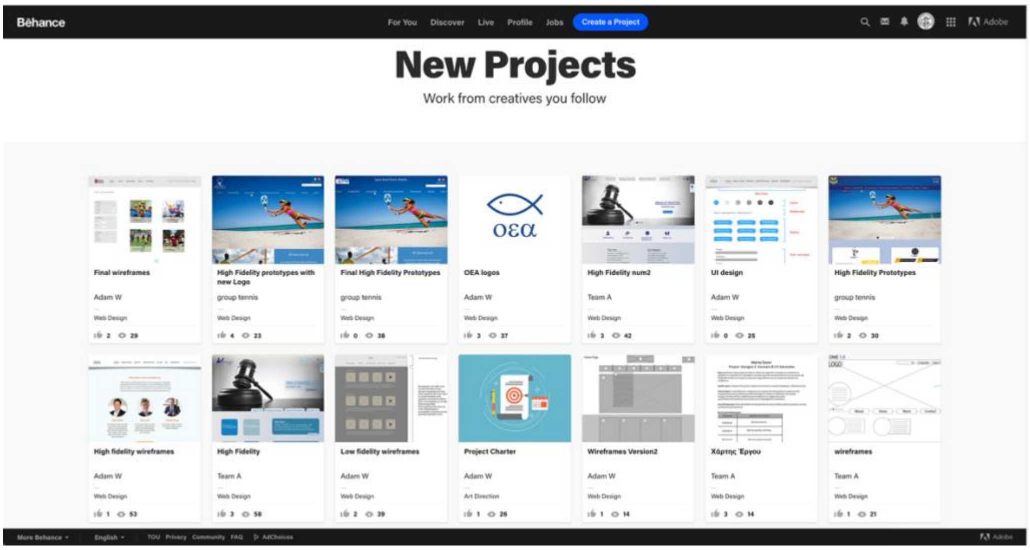


Figure 21: Adobe Behance teams' projects page (instructor's account)

3.2.8.3 *Single-User Context Technologies*

- Axure RP (Version 8.1, 2017) (*Axure Software*, n.d.) was used for rapid prototyping (wireframes, interactive proofs-of-concept) and diagrams.
- Adobe Photoshop (Adobe Photoshop, Version 13, 2017) (*Adobe Photoshop CC*, n.d.) was used for digital image/graphic editing and manipulation.
- Adobe Illustrator (Adobe Illustrator, Version 8.1, 2017) (*Adobe Illustrator CC | VGD*, n.d.) was used for vector editing and digital typesetting, graphic design and illustration purposes.

It should be noted that within the scope of this work, the last three - together with ConceptBoard and Adobe Dreamweaver (see 3.2.8.1) were considered *Creativity Support Tools* (CSTs), as they supported the field-specific Design activities which lead to innovative outcomes (Cherry & Latulipe, 2014; Gabriel et al., 2016). Figure 22 provides a visual representation of the three components (set, epistemic, social) of the learning ecology.

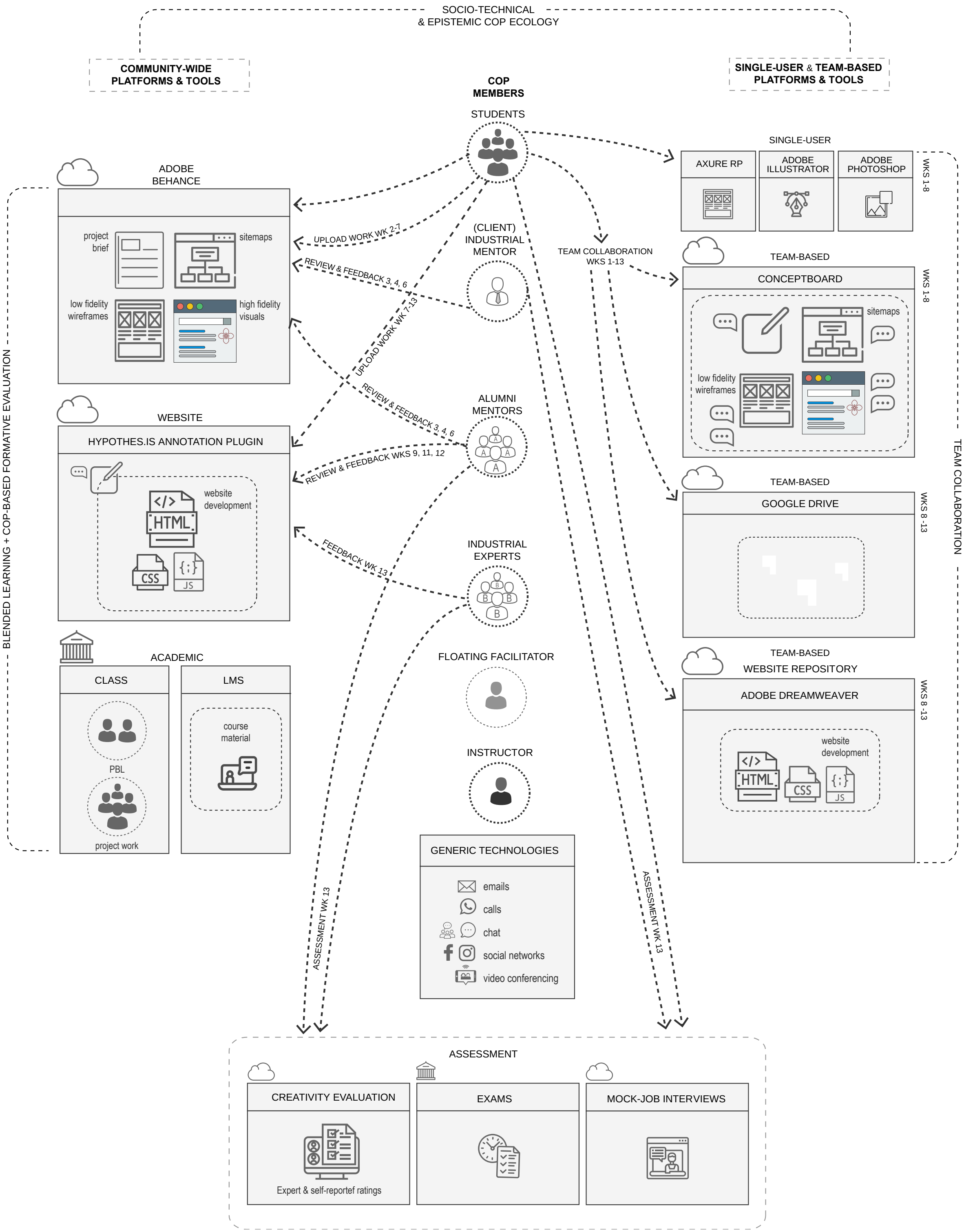


Figure 22: Cross organizational CoP ecology: set, epistemic and social designs

3.2.9 Data Collection

CoPs are typically complex social groups that warrant multifaceted analysis (interactions, processes, relationships, outcomes, context) (E. Wenger et al., 2011). In this work, the various studies' objectives were formed around the need to apprehend the CoP's role in learning, specifically in the field of Design studies. Guided by the respective research questions, multiple types of data were thus collected from various sources and perspectives in order to capture, explain and triangulate the *designed* and *emergent* dimensions of learning. Both quantitative and qualitative methods were employed, throughout - and at the close of the two 13-week semesters, to gather both immediate, as well as reflective evidence.

In this research the gathered data (see Table 8) include design artifacts, system logs, scores from (quantitative) instruments and other rating/evaluation procedures, as well as extensive qualitative information, from pre, on-going and post-intervention focus groups, interviews, observations and reviews (see Table 9). The following sections explain these in detail.

Table 8: Data collection methods in semesters 1 and 2

	Semester 1 (phase 1)	**G1**	**G2**
Interviews	10 participants (N=253 min, N=8,095 words)	✓	
Focus Groups	5 teams x 3 sessions (N=457 min, N=14,357 words)	✓	
Observation notes	Instructor (N=2,396 words)	✓	✓
ASCC	38 students	✓	✓
WSCMI	38 students + 38 evaluators	✓	✓
Final exams	38 participants	✓	✓
Behance feedback posts	5 teams, 3 alumni mentors, 5 industrial mentors (N=101 posts, 9,977 words)	✓	
Email communication	G1 N=54 email threads G2 N=25 email threads (team-based)	✓	✓
	G2 N=14 email threads (with alumni mentors)	✓	
Artifacts in Conceptboard & Google Drive	N=1393 (artifacts, chats, notes, boards)	✓	
	Semester 2 (phase 2)		
Interviews	8 participants (N=360 min, N=12,717 words)		
Focus Groups	5 teams (N=21 participants) x 1 session (N=318 min, N=18,498words)		
Observation notes	Interviewer		
Facebook group timeline (SN)	N= 205 posts		

3.2.9.1 Focus Groups

Within the context of this research, we borrow the term *focus groups* from Bloor (2001) who explains it as a method originating from market research, which is now widely used for academic social research. We also refer to them as ‘semi-structured’ focus groups as, they were steered according to a list of predefined question, yet, were open to develop in a conversational manner, depending on the issues that emerged and were deemed important by the participants. The focus group sessions aimed to collect qualitative information about the students’ ongoing work processes, as well as their attitudes and beliefs with regard to different dimensions of their social learning (i.e. classroom-based, CoP-based, relationships, performances, context, projections) processes. The researchers followed a ‘purposive sampling’ technique, which summoned the experimental group team members as the participants. Working with such predefined social groups provides the benefit of a) dealing with acquainted people who feel comfortable to talk about and express opinions, and b) hearing different perspectives about the social dimensions that shape the formation of collective ideas and decision-making, that are critical for understanding the learning phenomena. According to Bloor (2001), familiar pre-existing participant groups “may bring to the interaction comments about shared experiences and events and may challenge any discrepancies between expressed beliefs and actual behavior and generally promote discussion and debate”.

During the first semester (phase 1), the sessions were conducted with the five (experimental) teams (see Table 6), at regular iterations, depending on *member* and *time* availability, typically at the end of weekly classes (semester-weeks 4 - 13). During these, we sought to gather current and corroborated information through the team’s discussions and behaviors, concerning their learning and work-based processes, in both in-class (group-wide, team-based) and online (team-based, CoP-wide) conditions (Bloor, 2001). Observation notes were also taken by the facilitator during, or after the focus groups. Specifically, the various sessions probed for the participants’ views, reflections, narratives (stories) concerning the: a) *technology adoption*/*non-adoption* and co-configuration patterns, as well as aspects of their user experience based on the tools used, b) perceptions of (self/team) *creative behaviors* and performances, and their *epistemic cognition*, c) their *social arrangements*, interactions, and *feedback* experiences in the CoP, and d) the overall *benefits/drawbacks* of CoP membership with regard to learning.

In phase 2, focus groups with student teams took place at the end of the semester 2. Participants were asked to retrospectively consider and discuss their experiences, thoughts, feelings, attitudes and suggestions concerning the formal (university-based) and informal (CoP-based) dimensions of learning, as well as their perceived pre-professional identities, as these transformed over the entire academic year.

All focus group sessions (averaging 30 and 63 minutes for phases 1 and 2 respectively) were recorded, transcribed and analyzed in NVivo (*NVivo*, n.d.), a computer-assisted qualitative data analysis software (CAQDAS), using various analytical approaches. These are detailly described in the individual study chapters (4-9) of this dissertation.

3.2.9.2 Semi-Structured Interviews

We aimed at extracting more sensitive information that doesn't normally emerge in social discussions (i.e. focus groups), through one-to-one post-intervention interviews at the end of semesters 1 and 2 (Gill et al., 2008). In both cases, interviews were conducted using purposeful sampling, based on the *team*, *gender* and the *meaning-making* potential of participants. In other words, we ensured that we recruited at least one (most often two) representatives from each team, who were able to dedicate time and effort to reflect on, verbalize and externalize their meaning-making experiences which unfolded as part of their CoP participation (Flick, 2007). Like focus groups, participants were prompted to provide their views, attitudes and importantly, their *lived experiences* (i.e. social interactions, creative episodes, relationships) on the different *levels* (university, classroom-based, CoP-based) and *components* (technology support, social interactions, epistemic objectives) of learning. In semester 2, the interviews urged participants to provide more *holistic* and *interpretative* accounts of their CoP experience, by summarizing the benefits and challenges of their entire year experiences, the impact (if any) on their *identities* - as prospective graduates and young professionals. They were also asked to propose potential changes to enhance similar interventions.

The interviews (averaging 25 and 45 minutes for phases 1 and 2 respectively) were recorded, transcribed and studied in NVivo, using different analytical approaches; these are detailly described in the individual study chapters (4-9) of this dissertation.

Table 9: Pre, on-going and post intervention cycles of data collection across phases and studies

			Studies			
Phases		**Design & Implementation**			**Evaluation**	**Integration**
	ASCC validation	Set technology	Social collaboration	Epistemic outcomes	Value creation for learning	Design implications
			Semester 1			
Pre (+Post)						
ASCC	✓					✓
On-going						✓
Focus Groups		✓	✓	✓		✓
Field notes		✓	✓	✓		✓
Post						✓
WSMCI (Web Site Creativity Measurement Instrument)			✓	✓		✓
Final exams				✓		✓
Behance feedback posts			✓		✓	✓
Email communication			✓		✓	✓
Artifacts (i.e. Conceptboard, GoogleDrive)					✓	✓
Interviews						✓
Focus Groups		✓	✓	✓		✓
			Semester 2			
On-going						
Facebook group timeline (SN)		✓			✓	✓
Filed notes					✓	
Post						
Focus Groups					✓	✓
Interviews					✓	✓
Client Training & manual evaluation					✓	✓

3.2.9.3 Field Notes

The purpose of observation and note-taking in this research was to capture both verbal and non-verbal evidence. Instructor and floating facilitator *field notes* were generated through observation in the weekly classes in both semesters, as well as during the focus-group sessions held in semester 1 (weeks 3-13). These recorded information mostly recorded information regarding the technology setting, the WDD-UCD activities (see section 3.2.3.1), the CoP members' socio-epistemic interactions (team-based, CoP wide), the learners' creative moments and epistemic breakthroughs, their team coordination, responsibilities and procedures, as well as factors that steered motivation (interest, engagement), and affective issues relating to time pressures, trust, and team confidence. These were used to supplement, explain (or contrast) other types of data.

3.2.9.4 Feedback Threads

Feedback and subsequent responses, represent a key form of social collaboration (team-based, CoP-wide) amongst the members of the cross-organizational CoP. Feedback is also an inherent component of the Design disciplines' practice (i.e. architecture, engineering, technology), which place *critiquing* at the core of creative development (Adams et al., 2016; Huet et al., 2007).

Likewise, the feedback threads posted on *Behance* by alumni and industrial mentors (reviewing student deliverables in semester 1) were collected (N=132 posts, N=9,977 words, M=75 words per post) and content-analyzed using Cummings' et al (2016) coding scheme, which classifies feedback based on its *focus*, *type* and *tone* dimensions. The analysis of data based on this coding scheme is presented and thoroughly discussed in chapter 6.

3.2.9.5 Assessment Scale for Creative Collaboration (ASCC)

The ASCC (Wishart et al. 2011) investigates participants' (i.e. learners') perceptions of *creative collaboration* in computer-supported collaborative learning (CSCL) settings. Wishart et al. (2011), as the original creators of the instrument, focused on the dimension of 'creative collaboration', drawing from primary CSCL theories (Dillenbourg et al., 2009; Lew et al., 2013), and explained their choice of term, as the "collaboration process between people, working on collective tasks in the creative or other industries". They posited that this process is initiated by ill-defined problems, driven by a series of *imaginative, divergent thinking* and *problem solving* acts, that produce *novel* and (socially) *useful* outcomes in the end.

The ASCC (see Table 10) looks at *creativity* from various lenses, drawing from the theoretical perspectives of the *social* context, factors of *interest* and learning *regulation*, as part of a multi-faceted approach to its investigation (Glăveanu, 2014). Specifically, its original 25-item structure, seeks to elicit perceptions of the team processes that relate to *divergent* and *critical* thinking, the management of *ill-defined problems*, the role of *prior subject-level knowledge*, the *social* perspectives of co-located and distant *collaboration*, the level of *interest* and *engagement* in a task, and the individual or group *time-pressure* and *management* actions.

Table 10: Scale dimensions, descriptions and individual items

Dimension 1	**Synergistic Social Collaboration**	**Theoretical Origin**
9-item subscale that measures social collaborative learning and the conceptual variables of interest and emotional factors such as belonging, mutuality and trust		
Group interest in the task	1. Everyone in our group was interested in the task.	Interest
Trust between participants	2. Classmates/colleagues in my group trust each other.	Social Collaborative Learning
Orientation towards the task success	3. Everyone in my group wanted to make a successful product.	Interest
Safe atmosphere	4. We had a feeling of belonging together.	Social Collaborative Learning
Communication	5. We were all able to express our ideas, even controversial ones freely.	Creativity
Discussion of early ideas	6. We were able to share and discuss our early ideas with each other.	Creative Collaboration
Level of collaboration	7. We understood another's viewpoints at the start of the project.	Social Collaborative Learning
Adequate knowledge base	8. Our group had the necessary knowledge to be able to complete our task.	Social Collaborative Learning
Shared knowledge and goals	9. I had a good idea of what the others in my group knew that is relevant to this activity.	Interest
Dimension 2	**Distributed Creativity**	**Theoretical Origin**
7-item subscale that measures collective divergent thinking and externalization, the degree of tension and the perceived co-presence in distant teams		
Problem boundaries stretched or broken	10. We weren't always certain about how to carry out the task which led us to explore different possibilities.	Creativity
A degree of disagreement or tension	11. We sometimes disagreed but we discussed our different points of view.	Creativity
Group-based time pressure	12. My group were pressured to complete in time.	Time Pressure
Degree of co-presence (formally - text based)	13. We were able to share information with the other group members formally e.g. in a wiki or shared document.	Interest
Possibilities for externalizing representations	14. We could see or find out what other people knew or were thinking about. For example, we could draw, write or build things on the computer that the other group members could see and/or read	Creativity

Degree of co-presence (informally - SN)	15. We were able to chat informally with the other group members via text or social networking.	Interest
Level of divergent thinking	16. My group generated different and novel ideas in response to the task.	Creativity
Dimension 3	**Time Regulation and Achievement**	**Theoretical Origin**
5-item subscale that measures the degree of individual and collective time-management as components of learning regulation that link to achievement		
Stretching boundaries	17. We went beyond the set task.	Creativity
Group-level time management	18. Our group organized our time for learning well.	Time Management
Individual time management	19. I organized my time for learning well	Time Management
Emotional expression	20. The set task/activity enabled us to express our emotions.	Social Collaborative Achievement
Level of imagination	21. Between us we used a lot of imagination	Creativity

Employing a 7-point Likert scale (with 1 = not at all present, 7 =very much present, in reference to the condition being investigated). In an initiative to validate the instrument's psychometric properties, the ASCC was completed by a total of 236 international undergraduate and graduate students with prior experience in CSCW projects. The participant sample falls close to the 10 observations-per-item approach, which indicates a 'fair to good' analogy (Barlett et al., 2001; Gorsuch, 1983; R. H. Pearson & Mundform, 2010). Participants were prompted to consider their most recent collaborative experience as part of their academic responsibilities, prior to completing the questionnaire.

Following the initial validation of its properties (see chapter 7), the instrument was then administered as part of a pretest/posttest (repeated measures) design to the 38 students of the experimental and control groups, as described in study 3 in chapter 6.

3.2.9.6 Web Site Creativity Measurement Instrument (WSCMI)

Aside of creative *processes*, this research aimed to evaluate the creative outcomes produced by students both within (experimental) and outside (control) the context of the CoP. The WSCMI instrument, developed by Zeng et al (Zeng et al., 2009) was used to evaluate website creativity (produced by students), based on seven key factors (total of 28 items), namely, *aesthetic appeal, interactivity, novelty & flexibility, affect,* *importance, commonality & simplicity and personalization* (see Table 11).

Table 11: Web Site Creativity Measurement Instrument (WSCMI)

1. Aesthetically appealing design	1. Artistic 2. Colorful 3. Energetic 4. Beautiful 5. Fascinating 6. Entertaining 7. Engaging 8. Attractive 9. Favorable 10. Desirable
2. Interactive design	11. Interactive 12. Animated 13. Multimedia-available 14. Dynamic
3. Novel and flexible design	15. Original 16. Appealing 17. Flexible
4. Affective design	18. Stimulating 19. Pleasing 20. Delighting 21. Exciting
5. Important design	22. Relevant 23. Important 24. Crucial
6. Common and simple design	25. Infrequent 26. Rare 27. Sophisticated
7. Personalized design	28. Personalized

According to the original authors, the instrument's construct validity relies on foundational literature (Zeng et al., 2009). Specifically, the WSCMI draws from four different theoretical areas of creativity:

a) *Generic creativity* theory drawing from psychology theory (Hennessey & Amabile, 2010; Sawyer, 2011)
b) *Product creativity,* specifically targeted at traditional hardware products, driven by underlying theoretical and empirical evidence (Amabile, 1982; Csikszentmihalyi, 1988; Horn & Salvendy, 2006, 2009). Specifically, the *affect*, *importance*, and *novelty* factors were integrated into the instrument

from the validated Productivity Measurement Instrument from Horn's & Salvendy's (2009) earlier study.

c) *HCI* and *computational creativity* which address the needs of more complex information technology products and computer-mediated environments, that support the *social co-creation* processes (Karakaya & Demirkan, 2015b). These place emphasis on how the creativity processes of users (authors, co-creators, developers) are sustained by technology, as well as the creative quality of the outcomes produced (i.e. systems, interactive applications, websites) (Hoffmann, 2016; Kantosalo & Toivonen, 2016; Shneiderman et al., 2006; Stephanidis et al., 2019; Zeng et al., 2012)

d) Dynamic, *website creativity,* which relates to interactivity, usability, changeability, personalizablility, aesthetic quality and appropriateness, as these are perceived by end-users (Albert et al., 2004; Avouris et al., 2001; Garett et al., 2016; Hassenzahl, 2018; White, 2006; Zeng et al., 2009). In other words, these involve the consideration of "both instrumental, pragmatic and non-instrumental, hedonic aspects" (Zeng et al., 2012) of websites, and the respective user experiences they generate.

The WSCMI uses a seven-point Likert scale with responses ranging from '*strongly disagree'* (1) to '*strongly agree'* (7). The instrument was used at the end of semester 1 by *alumni mentors*, *industrial experts* and *industrial mentors* in the CoP (N=10[1]), as well as 24 graduate students and four HCI researchers (total N=38 evaluators), to rate the student websites in both the experimental and control conditions (see Table 3). The sample was extended with additional evaluators, to ensure sufficient diversity and objectivity in the quantitative findings (see Table 3).

The factors and items of the scale were thoroughly explained (within the context of *website creativity*) to all evaluators, through real-time (collocated or online) instructive sessions.

[1] One industrial mentor evaluation missing

3.2.9.7 Knowledge Gains Assessment

According to Wenger (1998) knowledge is co-created socially through the meaning-negotiation processes in a community's practice. Aside of creativity – measured both in its perceived (ASCC) and actual dimensions (WSCMI), it was also important to uncover indicators of the students' subject-level or conceptual knowledge. This has been defined as the "relationships among items of knowledge" and the learners' ability to identify these links, pointing to a level of conceptual understanding (McCormick, 1997). Such knowledge-gain scores were thus extracted via the module's final exam (semester 1) in order to detect differences between students in the experimental (N=21) and control (N=17) conditions. The exams comprised 16 questions (12 multiple-choice, 4 open-ended) on various theoretical and technical topics. Examples of short, long and multiple-choice questions are presented in Table 12.

Table 12: Examples of three types of questions to assess conceptual knowledge

Short answer questions	
• Which graphics file type would you choose, if you had to optimize a full-color image with multiple gradients, to achieve a lossless image compression for the web and why? • Please explain the two main advantages of using a <label> tag rather than plain text in HTML forms.	
Multiple choice questions	
• Please select two of the following options, which reflect correct syntax for the label tag in an HTML form:	**a.** <label id='student'> long description </label> <textarea id='student'> text </textarea> **b.** <label> long description <textarea id='student'> text </textarea> </label> **c.** <label> long description </label> <textarea id='student'> text </textarea> **d.** <label for='student'> long description </label> <textarea id='student'> text </textarea>
Long answer - Essay type questions	
a. Explain the concepts of a) 'grid-based' and b) 'above the fold' design. b. Discuss how these translate to design heuristics for the web.	

3.2.9.8 Communication Frequencies

Communication frequencies (emails and feedback threads), are indicators of interest, involvement and commitment to a subject or a domain on behalf of learners. These were extracted from participants in both conditions, experimental and control, and involved team-based (intra) and community-wide (inter) communication data, that were analyzed to provide descriptive statistical information (see Table 25).

3.2.9.9 Facebook Timeline and Chat Logs

A closed access Facebook group was set up to facilitate the practice of the community. Relevant posts, ratings, reactions, shares and comments were extracted from the group's timeline. Likewise a class-wide group chat which students had initiated themselves since their first year, and the individual teams' chat logs were accessed and examined following participants' consent, at the close of semester 2, to avoid influencing participant behaviors prior to that. These were mainly analyzed from a quantitative lens (i.e. density of communication), in order to determine the extent of the students' communication and interaction.

3.3 Quality of Research: Trustworthiness, Validity and Reliability

Regardless of the paradigm and methodological orientation, there is consensus that any type of research should provide evidence concerning its quality (Liamputtong, 2019). However, different orientations are typically linked to different categorizations of *quality* – particularly in the cases of *relativistic* (i.e. constructivist, qualitative method) versus the *realistic* (i.e. positivist, quantitative method) orientations. Explicitly, four key criteria of quality for the former orientation, concern the *credibility, dependability, transferability* and *confirmability* of research, claiming to assess the *rigor* or *trustworthiness* of *qualitative* inquiry (relativist orientation) (Guba & Lincoln, 1989). At the same time quantitative (positivist orientation) inquiry is concerned with issues of *validity* and *reliability* for the appraisal of research (Savin-Baden & Major, 2010; Twining et al., 2017). The following sections will describe how and to what degree this research fulfills these criteria within the context of both orientations.

3.3.1 Credibility

Guba & Lincoln (2001) explain *credibility* as broadly equivalent to *internal validity* in positivist/quantitative approaches, denoting the accuracy of the research and its findings and asserting whether these can be trusted (Liamputtong, 2019). *Credibility* in qualitative terms, is reflected - amongst others - in the period of engagement in the research field (sufficient or prolonged), persistent observation, member checking (questioning participants about the accuracy of findings), triangulation and interpretation of findings with stakeholders (Flick, 2007).

Primarily, data collection in this work was conducted throughout the intervention's two 13-week semesters, and extended to weeks 14 and 15 in order to derive retrospective and more conclusive accounts of the CoP-driven learning effects (mostly in phase 2). Findings thus developed over time, following a *prolonged* period of *sustained observation* and other data gathering techniques from the principal researcher's part, both as an *insider* and an *outsider* in the field of study (DeWalt & DeWalt, 2011). Specifically, while the researcher as the instructor of the module, who was a legitimate participant in the learning ecology (insider), still lacked the opportunity to fully participate in the lives of students, and particularly their *team-based* or *team-to-team, team-to-alumni, team-to-industrial-mentor* encounters (outsider). Although this was feasible, the research design followed a less obtrusive approach to data collection in semi-private CoP interactions, to avoid influencing the participants' behavior and attitudes, due to excessive scrutiny; evidently, this is something that often leads to abnormal behavior or *reactivity*. Known as the *Hawthorn effect*, this phenomenon is defined as one amongst several threats to validity in quantitative research. Based on Adair (1984) we also argue that any probabilities of such a threat being raised (even to a moderate degree), were counteracted by the prolonged period of study, that helped normalize such *reactivity* in participant behavior.

Secondly, Leung & Chung (2019) posited that a solid *theoretical* or *analytical* framework, allowing for comparative and deductive types of analysis between the theoretical constructs and the collected data, is another way of enhancing *credibility* in a study. Likewise, this research is guided in its entirety by established theoretical and analytical frameworks relevant to social, networked and CoP-based learning. Specifically, it is primarily steered by design recommendations provided by the fundamental CoP theory (E. Wenger, 1998), and further targeted guidelines concerning the setup and implementation of VCoPs (E. Wenger, 2009). Its top-level analytical strategy is structured based on the ACAD framework (P. Goodyear & Carvalho, 2016) and a more dedicated vertical analysis of learning follows the Value Creation framework (E. Wenger et al., 2011), which examines the value of learning in communities and networks (see Figure 14). All aforementioned theoretical frameworks and models were conceptualized by principal theorists in relevant research areas (CSCL/CSCW, Communities of Practice) and were employed and validated across several empirical studies, as discussed in the literature review section (see chapter 2).

Additionally, this work similarly draws from a dedicated coding framework for content-analytic purposes, which is underpinned by established frameworks of written *feedback* in Design contexts (Cummings et al., 2016; et al., 2014) to analyze an important set of data relating to *social collaboration* in Design-oriented CoPs. The framework was also employed and extended in further studies in the Design and engineering fields (Cardella et al., 2014; Schut et al., 2019).

Furthermore, Creswell (2014) emphasizes the significance of releasing detailed aspects of the research design, so that "readers can determine for themselves the credibility of the study". Likewise, this work makes an extensive report of its *design* and *implementation* referring to the three primary components of CoP-based learning, specifically the *technological set*, the *social infrastructure* and the *epistemic ecology*, in accordance to the ACAD framework. It abides to the call for being *extensive* and *transparent* about the strategies and steps that researchers take, as the means to allow others to judge their accuracy.

Finally, participants were probed to examine and discuss findings from previous data collection findings with the researchers. Specifically, students were asked to *interpret* their perceived *creative collaboration* scores from the ASCC (interpretation of findings) in focus groups, while the one-to-one post-intervention interviews probed for clarifications, and confirmation/rejection of earlier focus group findings, across both academic semesters (member checking).

3.3.2 Dependability

Dependability is closely linked to *credibility*, as evidence of the latter also confirms the former to a certain degree (Shenton, 2004). It is mostly related to *reliability* in quantitative investigation, which verifies if the analysis and findings of a study are consistent across different situations over the course of time (i.e. in repeated states) (Guba & Lincoln, 2001).

Liamputtong (2019) suggests that the demonstration of *dependability* lies on two key premises in qualitative inquiry: a) *coherent* and *transparent reporting* of the methodology, methods, data and findings, and b) *triangulation*, using various methods or conditions, researchers or theories to gather and analyze data (Twining et al., 2017).

As previously discussed in terms of *credibility*, both the current chapter as well as the individual studies in this dissertation provide exhaustive descriptions and supplementary visual aids (i.e. diagrams, figures, tables) to empower the reader to thoroughly understand its methodological components and respective findings (point 'a'). Further, the same sections provide evidence of the overlapping methods employed, such as *interviews*, *focus-groups*, *observation* (*field notes),* and *feedback threads*, for triangulation purposes (point 'b'), and hence extract more dependable findings. We argue that this has enabled the primary goal of the *qualitative* investigation, that is, to extract *richer* and more *rounded* accounts of learning, rather than more *accurate* ones (Braun & Clarke, 2013; B. Wenger-Trayner et al., 2019).

3.3.3 Transferability:

Similar to the positivist account of *external validity* or *generalizability*, *transferability* is a criterion which provides proof of whether the study design or its findings can be transferred in different *populations* and *conditions*. However, it is true that qualitative inquiry responds weakly to this requirement, since it typically concerns smaller participant samples and carries observations that are largely *situated* within the context in which they transpire (Shenton, 2004). We thus agree with the views of Braun & Clarke (2013) who posited that such concepts of *reliability* and *generalizability* are at odds with the relativist/constructivist perspective, as it places greater emphasis on the *contextual* factors of a study, as opposed to generalization. It also sees merit in the *embodiment* and active engagement of the researchers, as *contextual* agents of data collection, and thus accepts their inevitable effect on the research process (Savin-Baden & Major, 2010).

In this dissertation, we have nonetheless discussed a moderate form of transferability criterion, based on how the research design and respective findings can be applied to similar and adjacent areas of Design studies in HE (such as the engineering, arts, technology, and HCI fields), by providing a full account of how these converge, based on their parallel purposes, criteria, processes and methods (see section 1.1).

Further, literature posits that *transferability* lies in the eyes of the beholder, constituting the *reader* responsible for judging the "viability of local application (testing localization rather than the more usual generalization)" (Guba & Lincoln, 2001). It is thus the concern of prospective investigators to assess if findings *relate* to their own contexts (Savin-Baden & Major, 2010). Again, this presupposes sufficient evidence and 'thick descriptions' of all contextual phenomena that shape the original research. Both the *credibility* and *dependability* sections in this chapter have provided proof of the extensive and rich information in support of this aim. In addition to the individual studies which offer such descriptions (chapters 4-9), we also provide evidence regarding the *transferability* of the *social infrastructure* (i.e. the CoP human capital), as a critical and constitutive component of cross-organizational CoP interventions, in section 3.2.7.

3.3.4 Confirmability

Similar to *objectivity* in quantitative research, this criterion defines the degree to which findings are robust, by justifying and tracing these back to the original data, without influence from the biases, preferences and characteristics of the researcher (Guba & Lincoln, 2001; Liamputtong, 2019). A similar concept relating to mixed methods designs, is termed '*interpretive consistency'* and refers to the extent to which the generated inferences are consistent with the reported data findings (Creswell & Clark, 2011).

In this work, some parts allowed for this; the content-analyzed qualitative data in this work (i.e. feedback threads in CoP-wide collaborations) for instance, were verified based on the input of a second rater, with a substantial-to-high agreement level (k = 0,76). This approach thus ensures objectivity for the findings rooted in this specific data.

Nonetheless, confirmability is not always achievable in qualitative inquiry, considering the significance of the researcher's role, bias and preferences in the whole process. As such, one of the strategies to confirmability rely on a transparent account of the researchers' predispositions, and hence possible weaknesses concerning the choice of methods employed in the study. A relevant discussion, aiming to inform the reader about the choice of methods and procedures followed in this work, is thus provided under the limitations section in the dissertation's conclusion (see section 10.5).

Finally, abiding to the consistent call to trustworthiness and transparency in demonstrating *confirmability,* we once again remind the reader of the rich descriptions offered in this dissertation, as well as the systematic triangulation of evidence concerning the investigation of the same or adjacent variables, in order to fulfill the different objectives and enhance the rigor of the research (Twining et al., 2017).

3.3.5 Sampling, Validity & Reliability

Halcomb (2019) asserts that in mixed methods research, individual criteria of quality must be appraised separately. Appropriate criteria of the quantitative inquiry concern the *sampling strategy* and *representativeness*, as well as the *validity* and *reliability* (psychometric properties) of the instruments employed in the research (Braun et al., 2019a). We discuss these next.

3.3.5.1 Sampling

Section 3.2.2 in this chapter provides a description of the sampling approach for the various studies of the research. The majority of the quantitative methods (website creativity, creative collaboration, conceptual knowledge scores) were conducted with both the experimental and control group students. In this case, the studies used *convenience* sampling, due to the pre-defined cohorts involved, these being, the two class groups divided by academic registration (graphic / multimedia direction) in the same course. According to Creswell (2014), a good strategy in this case, is to obtain some form of equivalence in the groups in terms of one or more characteristics, prior to the experiment. In this work, this was done in the following ways: a) the investigators confirmed that the (third-year) groups had previously followed the exact same syllabi (prior subject knowledge), since the first two years of the academic program are common for both directions, b) their previous two-year grades were obtained and compared, concluding that their GPAs were almost identical (see Table 2) and c) pretest scores were obtained and compared in the case of the ASCC tool (see section 3.2.9.5), deducing no statistically significant differences in the two conditions.

Additionally, although the sample *size* was not extended (N=38), we have previously tried to support its representativeness to the wider population of interest, this being, the scholars in the Design domains such as engineering, technology, HCI and architecture (Adams et al., 2016; Huet et al., 2007; Østergaard et al., 2018).

3.3.5.2 Validity and Reliability

Validity refers to "whether one can draw meaningful and useful inferences from scores on particular instruments." (J. Creswell, 2014). Amongst other criteria, it investigates if the concept under study is accurately measured. Goodman (2008) provides two main areas of validity concerns, these being *construct* and *external* validity. *Construct* validity refers to whether an instrument is representative of measuring a construct (i.e. creativity). Cronbach (1951) defines this as involving "the acceptance of a set of operations as an adequate definition of whatever is to be measured". Related to *construct validity*, sub categories involve *content validity* (if the instrument sufficiently incorporates all dimensions needed to be measured), and *face validity* (if the instrument's measuring potential is verified by experts).

External validity, the 2nd key form of validity includes two sub-categories, *ecological* and *population* validity, which verify the applicability of a study's findings to alternative a) settings and b) populations respectively (Goodman, 2008).

Aside of validity, another psychometric property, *reliability*, refers to the degree to which the findings of the instrument are consistent throughout repeated administrations to the (same) sample (Heale & Twycross, 2015).

In this research, we employed two pre-existing quantitative instruments (sections 3.2.9.5 and 3.2.9.6) for extracting scores on a) the perceptions of teams' creative collaboration in blended learning (or work) settings (ASCC), and b) the creativity of the websites produced by students (WSCMI), as part of the CoP intervention.

The ASCC was the outcome of an internationally funded project, based on the collaboration of 50 researchers and (university) teaching experts from 20 countries, while incorporating empirical evidence from the instrument's use in five different research project applications. Guided by the project's final report (Wishart et al., 2011), which offered a revision of the instrument based on the respective findings, we present an extensive support of the underlying ASCC literature which draws upon creativity, collaboration and technology theories in chapter 7 (section 7.4) of this dissertation. While this provides adequate evidence of the original *construct* validity, the instrument was never systematically assessed. The same chapter (7) thus provides an extensive report of the assessment procedure of the instrument's psychometric properties. Specifically, we factor-analyzed its structure using the ratings of 236 participants, and extracted reliability scores in order to judge its appropriateness for data collection in chapter 7.

With regard to the WSCMI (website creativity) section 3.2.9.6 in chapter 3 provides a brief analysis of the literature which underpins the instrument's *construct validity*. Aside of strong literature justifications presented in the original report, the original authors (Zeng et al., 2009, 2012) refined its primary factor structure following evaluation with 289 users, making a generally stronger contribution to the instrument's validity (Goodwin & Goodwin, 1991). Adequate *reliability* scores are likewise provided in the original report (Zeng et al., 2009) as well as in our findings (see section 5.3.1).

Finally, this research may present limitations in the quantitative inquiry, with regard to *external* validity – and most importantly - *population validity*. It is difficult to generalize the findings (creative collaboration, website creativity) of a small sample (university, convenience sample) to different demographic conditions. That said, there may be greater confidence in both instruments' *ecological* validity in this case, since a) testing occurred in a natural (classroom) – versus a controlled (lab-based) – environment, which is drawn from and resembles real-world sets (i.e. students in comparable disciplines and settings), b) the stimuli under investigation (websites, events, and facts) are naturally-occurring and concrete - rather than abstract and arbitrary, and c) the participants' behavioral responses are arguably representative of the real world, since score-based tools (i.e. scales, questionnaires) are typically used for evaluating such stimuli in real-life situations (Gouvier & Musso, 2014).

3.4 Summary

This chapter outlined the ontological, epistemological, and methodological orientations of the research and provided rationalizations as to the appropriateness of a mixed-methods multi-phase design for this particular work. Individual methodological justifications were also provided for all data collection approaches. In addition, it includes rich descriptions of the research context, the participants, the procedures and the data gathering processes. Finally, the quality of the mixed method research design is appraised. The following chapters constitute the six studies which comprise the entire body of research in this dissertation and provide thorough information on the analytical and interpretational aspects of its design.

4 Phase 1 – Study 1: Design and Adoption of a Cross-organizational Technology Configuration

Phase **1** - Design & Implementation – aims to inform about the *design* and *enactment* of the cross-organizational CoP ecology that was integrated into HE Design module to enhance learning processes and outcomes. We remind the reader that the different dimensions in all phase **1** investigations, were defined according to the ACAD framework (see 2.5.1). This dictates that activities and outcomes in learning are physically or *technologically*, *epistemically* and *socially* situated.

Study **1** explores the technology configuration *setup* of the cross-organizational CoP and reports on the type and level of its adoption by learners, as members of the CoP. Its findings make an important contribution to the design principles under the Set component of the cross-organizational model.

Results from this study have been published in the *International Journal of Human–Computer Interaction* (Mavri et al., 2019a).

4.1 Introduction

The study presents the design of an affordable technology configuration for a CoP that can support the social learning processes of students in the HE Design disciplines (including engineering, technology, HCI, architecture). As previously mentioned, these disciplines share a number of characteristics: a) guided by a social and situated philosophy, they rely extensively on the social infrastructure (collaborative teams) and the real-life needs to support creative collaborations for the development of innovative products that serve a real-world purpose (L. Dym et al., 2005), b) they tend to follow a user-centered design (UCD) approach, requiring the systematic participation of various stakeholders (i.e. end-users, clients, experts) across multiple design and evaluation processes (community-centered) (Lazar et al., 2002), and c) their technology needs tend to include code-development tools (programming), visualization (brainstorming, mapping, diagramming), creativity-support (sketching, modelling, designing, animating), and communication activities (i.e. social networking, chat, conferencing) (Gabriel et al., 2016; Nguyen et al., 2016).

The perspectives from which to investigate these CoP-related process and outcomes vary; it could for instance be the students', the faculty's, the industrial members; or other stakeholders'. While in their entirety, they all help illustrate a more comprehensive picture of CoPs in HE, the scope of this research focuses solely on the learners' perspective, while the perspectives of other stakeholders remain to be explored in future work.

As such, in this study (Figure 23), the overarching research question is as follows:

RQ1: What constitutes an appropriate technology configuration design for cross-organizational CoPs in HE Design studies based on respective technology adoption findings?

This is divided in the two sub-questions which follow:

- **RQ1a:** How can a cross-organizational CoP's technology configuration be designed to address the collaboration needs of HE learners in the Design disciplines?
- **RQ1b:** How is the technological configuration adopted by the learners and what are the implications for the design of similar configurations?

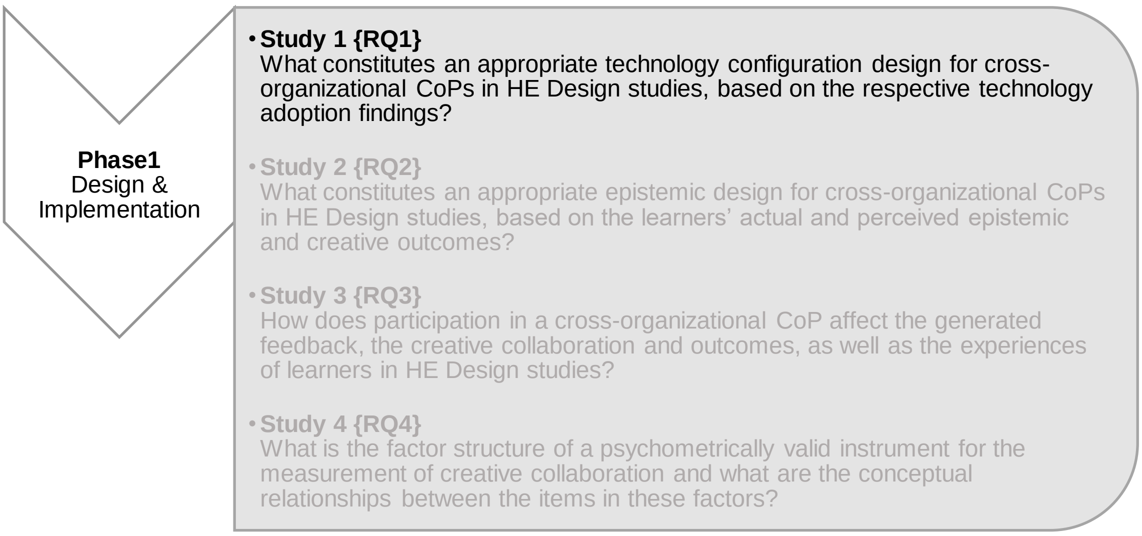


Figure 23: Study 1 overarching research question

4.2 The ‘Organic’ Community

It is important to mention that shortly after course initiation, the existence of a natural, self-formed CoP was evident, as noted in the instructor’s and facilitator’s field-notes. This was later-on also recorded in the focus groups and interview sessions. An initial community of students had apparently grown informally amongst classmates, based on their common status, purpose, interests and concerns within the domain, since the beginning of their studies. This does not mean to imply that communities are natural by-products of any social formation (E. Wenger, 1998). Rather, they present characteristics that are constitutive dimensions of a CoP. We discuss these below as they form a basic prerequisite for all the studies that follow in this dissertation.

4.2.1 Constitutive Dimensions of the CoP

It is important to caution against misjudging any ‘social configuration’ (group of friends, a class, an operational team) for a CoP, since this would constitute the CoP philosophy meaningless (E. Wenger, 1998).
A CoP presupposes the existence of a *domain* (of knowledge), a *community*, and a *practice*. In this work we provide evidence that the participants attached their goals and efforts to a specific domain - the Design domain – as members of a community in which they socially connected, interacted, generated bonds (and prospects of future relationships), co-created knowledge, tools, resources and behaviors, and co-developed artifacts over time through a common *practice*; that is – primarily - the “practice of being students” (A. DeChambeau, 2017), the practice of becoming (and being assisted to become) prospective practitioners, and the practice of being professionals who aspire to shape the Design workforce and steer the Design scene effectively.

Although sharing overlap with other social groups, such as communities of interest (CoIs), project teams and informal networks, the CoP in this work exhibited distinct characteristics that help demarcate its nature. In brief, it comprised a homogenous group of members who originated from the same *discipline* and subscribed to a common knowledge domain (Design), as opposed to the *multi-disciplinary* orientation of CoIs. Thus, with the exception of the ‘industrial mentors’ (as ‘clients’ who are also provisioned by the original participation model as shown in Figure 5), the heterogeneity of membership in this CoP stems from an organizational (academic/industrial) rather than a disciplinary context. That said, foundational CoP theory (E. Wenger et al., 2002a) does in fact, allow room for disciplinary heterogeneity, in cases when the community requires the help of ‘intellectual neighbors’ (i.e. to solve interdisciplinary problems, create guidelines etc.). The CoP model in this work also differed from the case of project-based teams, who are strictly driven by well-defined assignments and measurement criteria, into forming ‘task-driven partnerships’ (Farnsworth et al., 2016). Instead the CoP members in this study participated in an organically-developed community (by student peers, early on in their studies), through sustained risk-free expression, the sharing of ideas, experimentation and social relationships. It was enriched with the external memberships (as mentorships) later on. The CoP presented in this work also deviates from the concept of an informal network, as it was largely driven by collective (CoP identifying) – rather than individualistic - intentions.

Importantly, the pursuit of a *joint enterprise*, through *mutual engagement* and a *shared repertoire*, represent three constitutive dimensions of a CoP, denoting the coherent relationship between *community* and *practice*, according to foundational theory (E. Wenger, 1998). We provide brief evidence on how these were reflected in the context of this research below.

4.2.1.1 Joint Enterprise

As mentioned above, a spontaneous CoP had evolved amongst classmates since year one of their studies, based on their common *status*, *goals*, *interests*, and *limitations*, that were considered collective. Students specifically mentioned:

> [Team B member: We were all trying, we focused on similar goals, that was, to achieve something (in the domain of Design) […] yes, this was the goal, for all of us!]

Yet, the expansion from an organic to a partially-steered, cross-organizational community introduced diverse memberships, rich information and new relationships, transforming these goals consistently across the academic CoP membership. The *joint enterprise* entailed not only gaining proficiency and sound academic grades as it did in the beginning, but also managing prospective industry connections and opportunities that emerged, gaining relevance in industry standards and methods, and working towards professional outcomes for the real-world practice, in accordance to the following statement:

> [Team A member: I am entering the industry while still being a student. I have to face the industry.]
>
> [Team C member: Being evaluated by industry experts pushes us all to create something remarkable.]

Likewise, similar objectives were pursued by expert CoP members; these being, to have an active role in guiding the learning practices in HE and thus preparing the next wave of graduate human capital to enter the Design and adjacent industries. In this case, the memberships' (academic/industrial) common enterprise was thus geared towards *authentic* learning, to generate skills, outcomes and prospects that have real-world value for the collectively formed Design scene.

4.2.2 Mutual Engagement

Students participated in a spontaneous group-chat to connect socially and assist each-other on academic matters; for instance they posted course-related information, announcements and technical support snippets and engaged in collective problem-solving processes, as demonstrated in the following example:

> [Team C member: "Anyone having server problems when uploading?"]
>
> [Team C member: "I can't… it doesn't work for me :("]
>
> [Team E member: "I cannot view the remote files in order to upload the local ones"]
>
> (attached a screen-shot of the error message)
>
> [Team D member: "Did you change your folder's location?"]
>
> [Team E member: "Can I change the path of the folder?"]
>
> [Team C member: "You can, if you edit the settings in 'manage sites'"]
>
> [Team E member:: "Thanks, I got it working now!"]

Additionally, strong social *connections* and *exchanges* were observed online, in the classroom, during break-times and recorded in self-reported data. Aside of academic incentives, students interacted in additional dimensions of their socially-shared lives (Wisker et al., 2007). For instance they assigned community members a rotational responsibility of fetching meals, so as to allow the rest to focus on their work, especially when project deadlines were close. Such initiatives indicate a high degree of *mutual accountability* towards supporting and sharing the load, in order to allow everybody the chance to progress with their goals, which were perceived as a *joint enterprise* (E. Wenger, 1998, p. 87).

Similar acts of engagement were recorded on behalf of external mentors, who provided systematic feedback throughout the life of the community, that exceeded their project-related responsibilities, such as advice, mentoring on design-related issues and providing helpful resources (design resources, software, articles etc) for the students. Importantly, the large amount of Behance posts in the form of *recommendations* and *advice*, rather than brief judgements, indicated sustained *commitment* to the practice (Mavri et al., 2020a). Additionally, members' efforts to maintain momentum and 'aliveness' at times when participation was low, as acts of 'community maintenance', represent "the kind of coherence that transforms mutual engagement into a community of practice" (E. Wenger, 1998, p. 81).

4.2.3 Shared Repertoire

Aside of collocated expressions and routines (i.e. labels, stories, gestures), the community was observed to have developed specialized means of online communication (language, symbols). The members' chats revealed an adopted lexicon, containing abbreviated expressions and memes for daily exchanges (Dawkins, 1981). The use of *greeklish* (greek text in latin characters and reverse), allowed for shorter but more inclusive words:

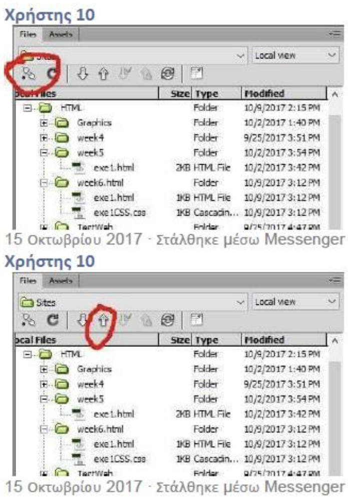
> [Team C member: "Θενξξ," "Ομγκοτ," "NVM"]
> (emphasized 'thanks', abbreviation of 'Oh My God' using Greek characters, abbreviation for 'NeVerMind')

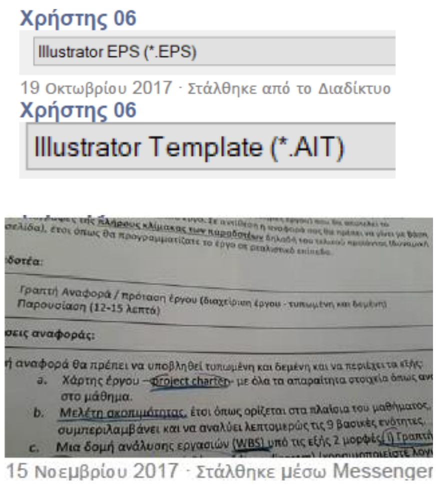
[Team B member: “ipa lathos!!! create → adobe illustrator object to kouti.. je epilegeis curves!!!!”]
(greeklish with abbreviations for: “I was wrong, create a box in Adobe Illustrator and select curves,” using deictic symbols (arrow) and communicating emphasis with exaggerated punctuation)

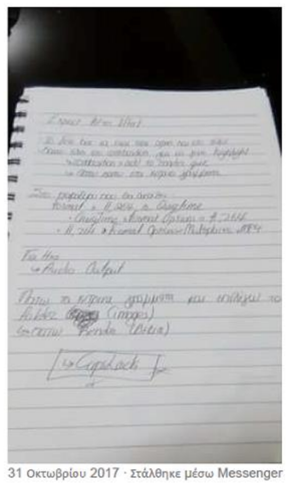
Resources were also frequently posted online, including software download URLs, useful articles and screen-shots of important artifacts (notes, briefs, photos) (see Table 13). These materialized both on a class-group and a community-wide level.

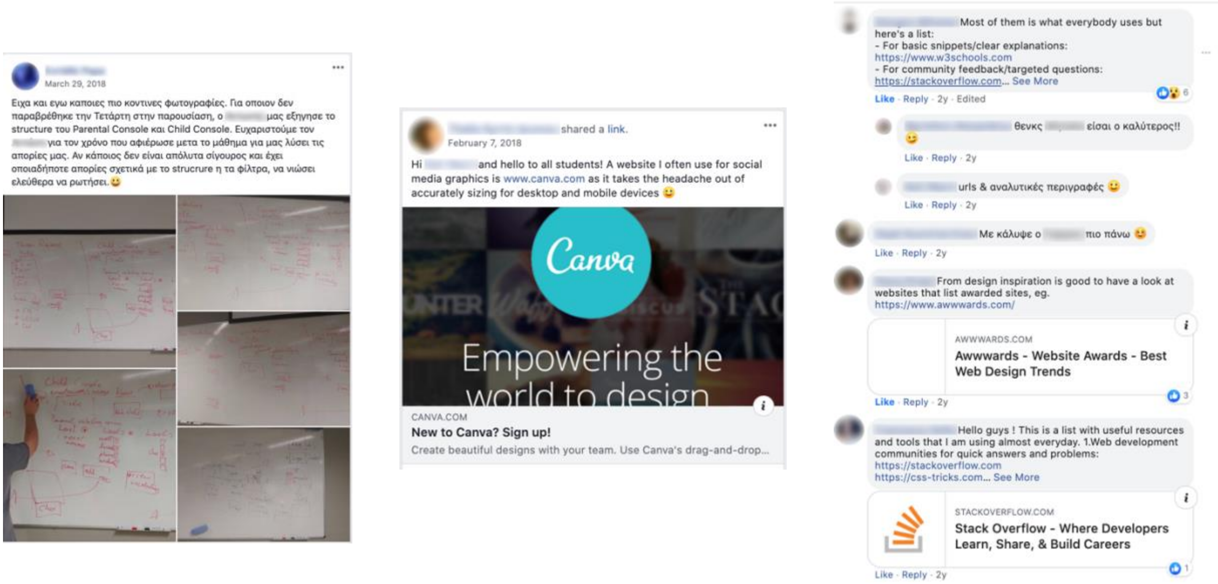
All of the above represent both the explicit and tacit knowledge that was co-created over time, reflecting a “history of mutual engagement” (E. Wenger, 1998, p. 89) in the CoP practice.

Table 13: Collective artifacts as indicators of shared repertoire in the CoP









4.3 The Digital Setup

Wenger White and Smith (E. Wenger et al., 2009) proposed three key steps for CoP technology design and administration as part of a VCoP framework, presented in Table 14. While described in the *methodology section 3.2.3*, the first two steps are briefly outlined in the following sections, as they also address the research sub-question RQ1a in this study. The third step, which is dependent on the outcomes of the first two, is discussed in section 4.5.2 (co-configuration).

Table 14. Stewarding technology steps for digital CoPs (VCoPs) (Wenger et al., 2009)

- Step1: understanding the community, its characteristics, orientation, and current configuration.
- Step2: providing technology, choosing a strategy, selecting a solution, and planning the change.
- Step3: stewarding technology in use, in the life of the community and at its closing.

4.3.1 Step 1: Mapping Community Orientations to the Study's Process Model

Orientations represent the primary required activities of a CoP (i.e. meetings, projects, networking), and serve as the basis for defining its *technology configuration*. Following directions from the VCoP framework (E. Wenger et al., 2009), and based on the fact that the community was not yet fully formed prior to the intervention, the tech *steward* (instructor) enquired about prospective *orientations* to instigate discussion with members, and prompt them in this way, to formulate their practice needs. As such, the steward created “an intended community profile in terms of orientations and their variants” (E. Wenger et al., 2009).

The primary aim of the technology was to facilitate collaborative practices among the CoP members. Aside of informal member discussion, field-specific activities were derived from related theory. Since this was a WDD course following a UCD methodology, we borrowed from WDD and UCD literature combined (see sections 3.2.3.1 and 3.2.3.2), to choose the appropriate index of activities (see Table 15 and Table 16).

Table 15: WDD process model based on Lowe & Eklund’s (2002) WDD and Vredenburg et al.’s UCD (2002) models

Web Design & Development (WDD) process model: phases and activities			
1.	Project planning	**a.**	Research & documentation (subject and users)
2.	Requirements	**c.** **d.**	Gathering Analysis & documentation
3.	Project charter / proposal	**d.** **e.** **f.**	Author & document Publish online Client feedback
4.	Content	**a.** **b.** **c.**	Define needs & document Provisions / exchange / delivery Store & share
5.	Sitemaps WBS (work-breakdown-structure)	**a.** **b.** **c.** **d.** **e.**	Card sorting Create & document Showcase online Client feedback Informal expert evaluation
6.	HTA (hierarchical task analysis)	**a.** **b.**	Test tasks & subtasks Create & document
7.	Time-planning	**a.** **b.** **c.**	Create & document Publish online Client feedback
8.	Ideation and visualization: wireframes & annotations (low fidelity)	**a.** **b.** **c.** **d.**	Iterative design & documentation Online showcase Client feedback Informal expert evaluation & feedback
9.	User testing, role-playing, walkthroughs, interviews		
10.	High fidelity prototype development	**a.** **b.**	Iterative design & documentation Showcase online

	c. Client feedback **d.** Informal expert evaluation & feedback
11. Heuristic evaluation	
12. Development	**a.** UI development **b.** Publish online **c.** Client feedback **d.** Informal expert evaluation & feedback **e.** Formal expert evaluation

4.3.2 Step 2: Technology Acquisition Strategy

Communities are driven by various factors when choosing their technology, such as what is commercially available or what is enforced by an organization, such us, specific business software for instance (E. Wenger et al., 2009). In this study, the academic members of the CoP had already been actively using free tools, such as Facebook and Google Drive. Yet extending these to the *external membership* of the CoP (alumni mentors, industrial mentors, industrial experts) warranted reconsideration of the initial technology configuration. Proprietary community platforms or tools were not an option, due to the diversity in the members' technical competence, as well as due to logistical and cultural characteristics (i.e. lack of administrative permissions) that were prohibitive. Additionally, no platform offered a full suite of the tools and features (i.e. the digital creative tools) that the community required for both generic and subject-specific activities. The technology acquisition strategy was thus developed based on a) ease, availability and affordability (i.e. either free or low-cost, e.g. monthly subscription-based tools), b) the efficiency of the tools in facilitating shared visual design functionality and c) their similarity to applications which the organic community was already familiar with.

Table 16: Mapped g*eneric orientations* & CoP *activities* from WDD process model (Table 15)

0	1	2	3	4	5	Orientations	Variants	WDD Activities
				✓		Meetings *Shared activity and useful outcomes for a specific time*	☑ Face-to-face/blended ☑ Online synchronous ☑ Online asynchronous	(community-context) 2b, 4-5, 7-10, 12
			✓			Open-ended conversations *Ongoing conversations as primary vehicles*	☑ Single-stream discussions ☑ Multi-topic conversations ☑ Distributed conversation	(team + community context) All phases

						for learning		
					✓	Projects *Solving problems or producing useful artifacts*	☐ Practice groups ☑ Project teams ☑ Instruction	(team + community-context) 1, 2a,b, 3a, 4a, 5a, 6a, 8a, 9, 10a, 11, 12a
					✓	Content *Creating, sharing and accessing documents, tools & resources*	☑ Library ☑ Structured self-publishing ☑ Open self-publishing ☐ Content integration	(team-context) All phases (community-context) 3b - 8b, 10b, 12b
					✓	Access to expertise *Internal or external access to expert knowledge*	☑ Questions and requests ☑ Access to experts ☐ Shared problem solving ☐ Knowledge validation ☑ Apprenticeship/mentoring	(team-context) All phases (community-context) 3c, 5cd,e, 7c, 8c,d, 10c,d, 12c,d,e
			✓			Relationships *Ongoing learning and availability between team members*	☑ Connecting ☐ Knowing about people ☑ Interacting informally	(team-context) 1, 2a-b, 3a, 4a, 5a, 6a,b, 7a, 8a, 9, 10a, 11, 12a
			✓			Individual participation *Diversity in people's backgrounds, communication styles & aspirations in the participation*	☑ Levels of participation ☐ Personalization ☑ Individual development ☐ Multi-membership	(team + community-context) All phases
		✓				Community cultivation *Focus on the effectiveness and health of the community to make things better*	☐ Democratic governance ☐ Strong core group ☑ Internal coordination ☑ External facilitation	(team + community-context) All phases
				✓		Service context *Serving a specific purpose that is central to the CoP identity (i.e. disseminate information or recruit members globally)*	☐ Organization as context ☑ Cross-organizational ☐ Other related communities ☐ Public mission	(community-context) 2a, 3b,c, 4b, 5c,d, 7b,c, 8b,c,d, 9, 10b,c,d, 12b,c,d,e

The proposed technology is described in chapter 4 and a detailed inventory, presenting the *platforms*, *tools*, *features*, *supported activities*, *context* and *deliverables* can be seen in Table 17 below. These are classified as 'team context', 'community context' and 'single-user context'.

Table 17: Technology configuration inventory for cross-organizational CoP needs

Platform 1: Google Drive (https://drive.google.com)				
Description	Tools	Key features	Context	WDD activities (Table 15)
- File storage and synchronization service - General productivity software - Word processing - Spreadsheets - Presentations	- **Google Docs** - **Google Sheets** - **Google Slides** - **Google Hangouts** - **Gmail**	-Shared file repository -Real time document co-editing -Visual status & activity indication -Editing, suggesting, viewing modes -Version history & restore functions	Online Multi-user Community + team context Sync/async	1: Project planning 2: Requirements 3: Project charter / proposal 4: Content 5: Sitemaps 6: HTA 7: Time-planning 11: Heuristic evaluation Notes: Co-editing, storing and managing documents and project assets, client presentations
Platform 2: Adobe Creative Cloud (https://www.adobe.com/creativecloud.htm)				
Description	Tools	Key features	Context	WDD activities
Self-promotion, consulting & online portfolio site & social-media portfolio service for creative professionals	**Adobe Behance**	- Team pages - Team projects: images, text, videos, posts - 'Appreciate' action - Post a job - Follow	Online Multi-user Community context Async	5 b-d: Sitemaps 8 b-d: Ideation and visualization (wireframes) 10 b-d: HF prototypes
SAS - software as a service model: desktop tool for raster graphics editing and compositing Raster-graphics editor (+ vector graphics editing)	**Adobe Photoshop**	- Multiple layers - Pens, brushes - Magic wand - Move, rotate, crop - Shape (vector) - Color modes - Animation - Effects filters - Effects plugins	Offline Single-user Team-context Async	10 a: HF prototypes
SAS - software as a service model: desktop tool for vector graphics editing used in the areas of typesetting, graphic design, interface prototyping	**Adobe Illustrator**	- Multiple artboards - Drawing, Painting - Typing - Shape/crop/cut - Move/zoom/pan - Perspective grid - 3D graphics - Version control - History	Offline Single-user Team context Async	8 a: Ideation and visualization (wireframes) 10 a: HF prototypes

SAS - software as a service model: desktop tool for vector graphics for web dev	**Adobe Dreamweaver**	- WISWIG + code editor - Live preview - Code/syntax hints - Built-in FTP - History	Offline/Online Single/multi-user Team context Async	12a-b: Development

Tool: https://conceptboard.com

Description	Tools	Key features	Context	WDD activities
Virtual team whiteboard (canvas) for the collaborative visualization of ideas, planning, brainstorming, and resources management	**ConceptBoard**	- Extensible whiteboards - Live color-coded participant pointers - Moderator mode (screen-sharing) - Video conferencing - Notifications - Real-time chat - Sticky notes - Activity streams	Online Multi-user Team context Sync + async	1: Project planning 2b: Requirements 4: Content 5: WBS 6: HTA 7: Time-planning 8a: Ideation and visualization Notes: Team brainstorming, mind maps, quick drawings and sketches, card-sorting, chats, visual research outcomes

Tool: https://www.axure.com

Description	Tools	Key features	Context	WDD activities
Subscription-based or perpetual license software for wireframing, prototyping, diagramming, documentation software tool for web and desktop applications	**Axure Pro**	- Widgets library - Master pages - Design canvas - Interactions - Annotations - Widget properties (visual & behavior) - Publish to live	Offline Single-user Team context	8a-b: Ideation and visualization (wireframes) 9: User-testing 10a,b: HF prototypes Notes: interactive prototypes for usability study

Tool: https://web.hypothes.is

Description	Tools	Key features	Context	WDD activities
App which allows for annotations in web pages, using comments contributed by individuals. Also comes in the form of a browse-based plugin.	**Hypothes.is**	- Selectable text to annotate - Public or private tags & posts - Replies / shares for annotations - Link to notes or whole pages - Collaborative annotations (groups)	Online Multi-user Community context	12c,d,e

4.4 Methodology

This study involved the 21 students of the experimental group only during semester 1 as Table 18 indicates. We collected qualitative data from focus groups with students, which took place between weeks 4 and 13, resulting into a total of 15 sessions with all teams (see Table 19).

Table 18: Study 1 participants

Phase	Study	Participant Groups	Semester
Phase 1 Design & Implementation	Study 1 Technology configuration design	G1 (N=21) students	Semester 1 (WDD-1)

Table 19. Study 1 data collection

Method	Participants & Sessions	G1	G2
Focus Groups	5 teams (x 3 sessions. N=457 min. N=14.357 words)	✓	

Important incidents and related insights on the technologies used were thus captured retrospectively - yet - while still fresh in the students' minds. The focus groups were typically held during or after classes in the university labs, with the project teams, the instructor as the moderator and the floating facilitator (see section 3.2.9.1). Guided by a set of questions, students expressed their views on the *technology configuration*. Specifically, students were prompted to talk about how they used the proposed tools – both for *team-based* and *community-wide* purposes, if and what issues they encountered, how they addressed these, as well as offer suggestions for more appropriate tools, if they so wished. As a pre-existing team, they were familiar with each other and felt comfortable to speak in the presence of other team members about these matters (Bloor, 2008). The team structures are presented under the Methodology chapter in Table 6.

4.5 Analysis and Findings

4.5.1 Technology Adoption Analysis

The term 'technology adoption' is most frequently associated with technology acceptance frameworks, with TAM (Technology Adoption Model) (Davis et al., 1989), being the most widespread. TAM has been validated and extended through multiple studies in diverse fields (Rauniar et al., 2014; Renaud & Van Biljon, 2008; Venkatesh et al., 2003). This model is typically used for *forecasting* technology use, using *intention* as the dependent variable. A psychometric instrument measures technology acceptance via a set of variables, such as *Perceived Usefulness* and *Perceived Ease of Use*.

In contrast, the purpose of this study was to gain a well-rounded view of the participants' experience retrospectively. We aimed to gather rich information and uncover unanticipated phenomena that may have emerged from the specific blending of a cross-organizational CoP's *practice* with a *technology configuration* and the field of the *Design disciplines* (a targeted niche). We therefore judged that a fully qualitative approach, flexible enough to allow for the emergence of new information, was more appropriate to gain a better understanding of the convergence of the three areas (J. A. Maxwell, 2012).

We employed inductive thematic analysis (Chi, 1997; Patton, 1990) for the qualitative data collected from the focus groups to investigate how technology facilitated or hindered participation in the CoP. We looked exclusively at the learner perspective, and tailored our research questions accordingly. We used a fully qualitative *reflexive* approach (Braun et al., 2019a) and presented the emergent coding scheme as an outcome of this process (versus a priori codebook for the analysis) (Saldaña, 2015).

In summary, the complete dataset underwent a preliminary scan and only relevant subsets concerning the role of technology were coded. Each team was defined as a case of analysis and complete argument chains (multi-sentence segments) were defined as a unit of analysis. This was due to the researchers being limited to extracting semantically inclusive inferences from finer-grained segments (i.e. single-line utterances) to inform the research objectives.

Next, a coding scheme reflecting a) the meaning of data and b) important theoretical variables of "the current domain" (Chi, 1997) was used for coding the selected subsets (see Table 20). In other words, while the codes and categories were derived from the data, some of these were found to closely reflect variables of CoP theory and were therefore titled accordingly. Specifically, certain codes and categories aligned with typical community challenges, otherwise known as *polarities*: a) *rhythm*: togetherness and separation (time and space), b) *interaction*: participation & reification (co-construction of artifacts) and c) *identity*: individual (see Table 20).

Simultaneous coding was applied (coding text in more than one code) to capture critical data perspectives (Saldaña, 2015). It was important for the researchers to document the multi-dimensionality of each inference as these could, for example, refer to definitive properties, such as a synchronous/asynchronous, team-only or community-wide activity that occurred in a certain tool and generated specific findings. Finally, a total of 7 categories and 382 code references were recorded (see Table 20). The most prominent categories and their inter-relationships are reported below, grouped by the software tools used in the study.

Table 20: Qualitative coding scheme for technology-related subsets from focus group data

Categories	Description	No. of codes	No. of references
Software/ platform	Reference to the tools most often used by the CoP, whether core (obligatory) or supplementary (optional)	12	48
Usability/ affordances (Norman, 1999)	Reference to issues relating to the affordances of the system (issues of awareness, concurrent viewing, perceptions of credibility and security)	19	46
Interaction features (E. Wenger et al., 2009)	Reference to the specific functionality facilitated by the software (video conferencing, alerts, file sharing, direct manipulation)	14	77
Identity (E. Wenger et al., 2009)	Reference to community-wide, team-based and individual activity	3	44
Rhythm: space (E. Wenger et al., 2009)	Reference to online, offline or other (i.e. online co-located) activity	3	44
Rhythm: time (E. Wenger et al., 2009)	Reference to synchronous or asynchronous interactions	3	47
Attitude	Reference to positive, negative or neutral attitude	3	76

4.5.1.1 Conceptboard

The participants considered this tool to have adequately facilitated team communication and coordination activities through voice and video conferencing, screen-sharing and chat (see Table 17). The system’s synchronous (live editing, video/voice) and asynchronous (i.e. sticky notes on elements, chat history) affordances were extensively used. Further, the large canvas and direct manipulation capabilities (pan, zoom in/out) effectively supported the kinds of experimentation required during the ideation phases:

teams particularly favored the ability to use natural gestures in "throwing and moving things" around, dropping resources on the canvas, and using it as a mood-board, a brainstorming environment, or a card-sorting board.

That said, some participants reported issues of awareness. Apart from team C who remarked that "watching everyone's cursors move around" on the canvas was helpful (see Figure 24), the rest stated that they were unaware of their peers' concurrent activities in the environment. In fact, members from teams B and D went as far to say that their teammates acted quite individualistically and didn't respect their peers' activities in the shared space. Similarly, awareness issues around *space* and *time* also surfaced. Participants reported not knowing what the most recent creations or edits on the canvas were:

> Team B member: It felt like a maze, because when someone inserted something somewhere in that chaos…there were a lot of things everywhere but you couldn't know what the most recent action was… to know what to do next.

Issues of ownership, like a lack of "safekeeping", thus became prominent. The ability to move or change artifacts on the canvas interfered with individual workflows and was perceived as intrusive and hence, counter-productive. Concurrent editing often led to overwrites and caused discord amongst teams:

> Team D member: Basically you can edit a piece of text...on one of the stickies and then you press enter to save it and it disappears all together! [someone else had deleted it in the meantime].

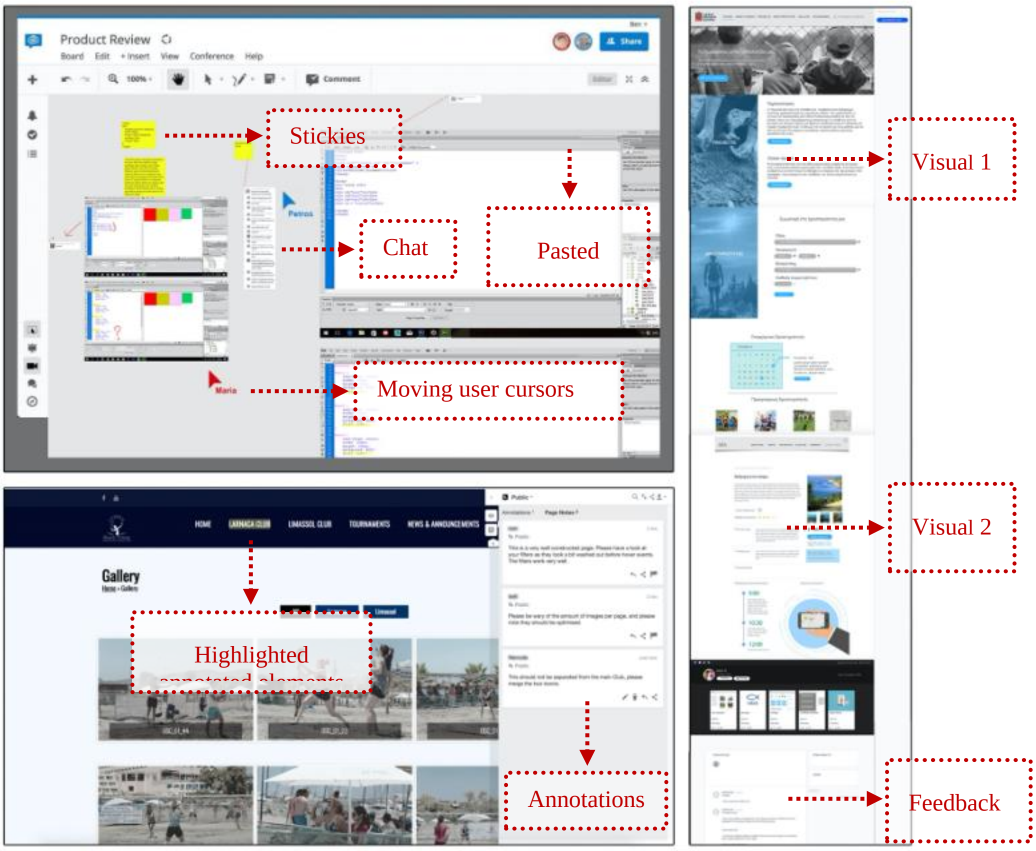


Figure 24: Conceptboard (top-left), Hypothes.is (bottom-left) and Behance (right) screenshots

4.5.1.2 Adobe Behance

Behance was used for uploading deliverables to be accessed by the wider CoP, so that members could view and post feedback below visuals, at the bottom of each page (see Figure 24). Teams were prompted to create *team* accounts and organize each deliverable phase into a different *project* (a page with multiple visuals). Students found uploading and organizing quite practical. The tool’s affordances were also good for online showcasing. However, its role in feedback exchange was somewhat problematic. The grouping of various visuals (i.e. home page, list-view, details template, etc.) generated long scrolling pages. Consequently, the comments were not physically close to the corresponding visuals. The tool’s inability to put these in proximity, forcing users to scroll back and forth when trying to put together visuals and feedback, was perceived to hinder the team’s workflow.

More difficulties were reported on the limited amount of characters (a maximum of 125) allowed in feedback posts. This resulted in comments split across consecutive posts, creating a frustrating and fragmented experience. The lack of rich-text-box functionality, such as lack of formatting options to indicate hierarchy or emphasis (i.e. bold, underline, bullet points) in the comments, was also negatively received, with teams commenting that the poor formatting capabilities hindered the communication of meaning amongst CoP members at times.

4.5.1.3 Adobe Dreamweaver and FTP Client

Dreamweaver CS6 (DRW) was used to transform the visual prototypes into functional web pages; these were then uploaded to a server via an FTP tool (see Table 17). DRW does not offer a synchronous multi-user editing facility. In terms of team collaboration, it offers partial version control through SVN (Apache Subversion), an open-source version control system (Wikipedia contributors, 2018). Based on its complexity and other testimonials that had reported issues, this pairing (DRW & SVN) was not considered a suitable option for beginner-level students, especially given that they were already dealing with a considerable load: learning how to code and use new software, understanding the server environment and managing external CoP stakeholders. Teams had to therefore work on shared files sequentially, rather than concurrently, using DRW's file 'check-out'/'check-in' functionality. Yet, as the projects progressed, deadlines and other pressures eventually imposed the need for concurrent file editing. For instance, the main stylesheet file (CSS) (with site-wide formatting, layout and behavior specs) was often required simultaneously by different team members. In doing so, some participants reported feeling confused, having to manually track and merge different user changes. As expected, this led to overwriting, delays and frustration:

> Team C member: They re-uploaded the file and it was spoiling others peoples' stuff.

The software's affordances in this case failed to support effective synchronous and asynchronous collaboration, and resulted in more effort and time pressure on the novice learner teams.

4.5.1.4 Google Drive, Docs, Sheets, Hangouts

Google Drive, Docs and Sheets were used for important weekly deliverables throughout the project phases, while Google Hangouts was minimally used for communication (see Table 17). Google Drive served as a primary repository for shared resource storage and document management. Interestingly, some teams reported that the tool could be enhanced if configured or used in conjunction with other software. For instance, team C members used it extensively alongside Conceptboard for collaborative exploration and experimentation. Nevertheless, specific areas within shared documents were designated by team members as ‘private’, in an effort to safeguard individual work and prevent problems similar to those faced in Conceptboard:

> Team C member: We used it at the beginning… to make a list of our own opinions […] but each of us had their own parts allocated in that document.

Likewise, team B further suggested that the process of feedback from the community could be better streamlined by pairing Google Docs and Behance in the future. With the use of cross-referencing to keep track, they proposed linking prototypes (Behance) to full feedback reports (Google Docs) to enhance their workflow. This could resolve the aforementioned issues of concurrent work/feedback, as well as the lack of rich-text-box functionality to format text in order to indicate semantics, while additionally allowing for effective documentation and searching activities. This arrangement requires targeted interoperability, which is to date not natively supported by these tools.

4.5.1.5 Hypothes.is

This tool, directly embedded on page elements in the form of annotations (see Table 17), was used by mentors and clients to post feedback on the webpages. This type of feedback was submitted over the final two weeks of the semester. The tool was well-received as immediate, efficient and thus highly practical for this purpose:

> Team B member: Instead of sending the code and having to indicate the line, this is a much nicer tool!

As Hypothes.is only offers two annotation modes: “*public*” and “*only me*”, some skepticism regarding the veracity of written feedback was expressed, as anyone could submit a comment. According to participants, additional owner-defined (customized) “*view & edit*” modes, could extend user privileges and better target activities suitable for either team-based or CoP-wide contexts.

4.5.1.6 Adobe Illustrator - Adobe Photoshop

These single-user CSTs were used to develop low and high-fidelity prototypes (see Table 17). The vast majority of participants agreed against the synchronous co-design and editing of such artifacts. According to multiple participant views, such stages of intuitive, creative and refined design work dictated a highly individual, independent, unstructured and unmonitored process:

> Team A member: When you are artist... You cannot do that… artistic activity cannot be collaborative in real time, like working on a common design.

While collaboration was welcomed and in fact, perceived as necessary during the earlier brainstorming, analysis, critiquing and orientation stages (Poole & Holmes, 1995), the creative development phases that came next required a more definitive division of roles. These tools were thus used by participants as intended, i.e. in a non-collaborative way.

4.5.2 Co-Configuration: Extending Technology to Appropriate the CoP's Needs

While the suggested technology configuration (see Table 17) was used in its majority without any significant problems, teams made further technology judgements or reconfigurations in order to address their collaboration needs. These are outlined below.

4.5.2.1 Skype

The majority of teams introduced Skype to their team processes, for voice/video conferencing purposes, both in their teams as well as with remote CoP members (i.e. clients) during the course of the semester. The case of team C differed, in that they also used this tool during their development processes. Specifically, a team member actively worked on design artifacts using *single-user* context software (i.e. Adobe Illustrator), in conjunction with Skype's shared-screen mode, which allowed for continuous communication with teammates. As such, they exchanged suggestions, directions and *co-negotiated* design decisions, adopting a semi-collaborative approach through the affordances of the tool:

> Team C member: "We were all connected and we coordinated and talked and asked things like "why do we do that?" or agreed like "ok,

> you are right, proceed" – during work […] the reason we want to do that is so that we can correct each other's mistakes"

In fact, unlike others, this team searched for a real-time collaborative vector editor. Adobe XD, which allows such functionality was discovered by the team members at week 7. It was however decided to proceed with the tools used so far, to avoid learnability delays and the risks that typically emerge with new technology.

With respect to other activities such as flow-charting and diagramming for example, the team went a step further to use Team Viewer (remote desktop tool). This decision enabling other collaborators to edit artifacts directly, even if it was developed within *single-user* context software.

4.5.2.2 Conceptboard

Conceptboard's shared canvas was in some cases, extended to act as a document management environment by teams A and D, who referred to it as a *central information space*. Specifically, team members treated segments of text information (i.e. client contact information, meeting-minutes) as *spatial entities* on canvas, that they physically handled (i.e. drag, move, zoom), instead of using other tools whose interface allowed for the creation of file directories, and facilitated search and navigation capabilities.

In addition, team C tried to locate other similar tools, which integrated *vector-editing* capabilities for editing UCD artifacts (i.e. sketching, prototyping, diagramming, mapping) to avoid using separate software. The same group overcame *time-related* issues, by defining and color-coding specific *weekly* work areas on their Conceptboard canvas.

4.5.2.3 Dreamweaver

As previously mentioned (see section 4.5.1.3), version control systems (VCS) allow different users to work independently, yet ,concurrently, by merging individual changes automatically without loss of information. Faced with the technical challenges of installing and configuring additional software to enable such functionality in Dreamweaver, teams resorted to other solutions instead. Specifically, teams C and E generated the basic templates first, using a single PC in a co-located setting, and then divided and assigned the implementation of different page clusters to pairs (subgroups within teams). This allowed them to work on independent CSS files, one for each page cluster), with the aim to eventually merge these into a single file in the end.

However, this comes into conflict with the benefits of using CSS technology, which aims to ensure economy of use, ease of maintenance, and visual or interactive consistency for the entire website via a single file. Alternatively, team A assigned one person at a time to work on the code, while the rest of the team members worked on other tasks instead. In this case teams had to renegotiate their members' roles and responsibilities, and to reconfigure their team processes, in order to work around the technology's limitations.

4.5.2.4 Behance

Aside of its showcasing and reviewing purposes, the platform was also used extensively for *referencing* purposes, that is, it represented an organized visual index for team-based or community-wide interactions (i.e. meetings, email exchanges etc.). As already mentioned, the grouping of various visuals (i.e. home, secondary and list pages) and their several versions, into one single project (one page), resulted in a very long page, which made it difficult for users to read comments (long scrolling down) and view the visuals in reference (scrolling up) at the same time. Some teams decided to overcome this, by opening two side-by-side browser tabs (i.e. left-tab: visual, right-tab: forum comments), and to switch tabs as needed, avoiding the long scroll.

On this matter, some teams discussed the option of saving each visual as a different project, in order to have all comments summarized and proximally associated under each visual on the pages This prospect was later on rejected, as it would potentially generate more effort for them to open several different projects at once. They commented that the visuals on different pages were still associated to one another, and also required concurrent viewing practices, to derive conclusive feedback, as the following example illustrates:

> Team E member: Then there would be no directness between the prototypes… I would have to go look for the following prototype in another page, to search through the different *projects* in Behance, go back, click, open a new tab etc. etc. It's too much work.

Having thus explored multiple possibilities, the teams decided to maintain the normal classification method (one project per deliverable stage), but to adjust their viewing practices accordingly, to enable faster tracking of feedback and the visuals in reference.

4.5.2.5 Facebook

Rather than using a dedicated group page (i.e. timeline), the Facebook messenger tool (for chat and live conferencing) was used extensively by subgroups, as well as for reaching out to external community members like, conducting video-conferencing sessions with clients. Students explained that they are familiar and commonly used tools.

> Team D member: "We are used to these tools, that is why we are saying we don't want to use anything too different I believe…"

4.6 Discussion

The objective of this study was to describe the cross-organizational CoP technology configuration localized to the learning requirements of an HE course in the field of Design disciplines (i.e. architecture, engineering, HCI). These disciplines share perspectives, such as the fact that they rely on the creative collaboration of teams whose purpose is to produce novel products for the real world. In doing so they require a blend of technologies for technical development, visualizations, creative design and communication, and are largely user-driven, thus requiring the participation of several members from each community. In investigating and describing the design of an ecology that can support these perspectives, the study examined the type and degree of technology adoption by the students that participated in the CoP.

First, the presence of a CoP – as opposed to any basic social formation – was corroborated through supporting evidence. As such, the pre-existing *organic* community, as well as the *extended* community (cross-organizational), presented critical characteristics which denote the coherent relationship between *community* and *practice* required of CoPs. Specifically, various dimensions of a *joined enterprise, mutual engagement* and a co-developed *shared repertoire* emerged from this evidence. As such, there was a) systematic (in-and-out of class) peer co-activity and high levels of accountability to address *common academic goals* and challenges, as well as to support the social bonds that had evolved along the process b) dedicated interest and commitment in the external connections and collaborations with industry stakeholders (alumni, experts, clients) to serve the projects' needs; these were perceived as interactions of significant real-world value, and c) a co-created set of expressions, routines and other specialized means of communication (particularly in online contexts) to enable faster and more effective exchanges in the practice. The CoP members were evidently "using technology to learn together" (Wenger, 2009), something that sets a solid base for the perpetuation of learning beyond the life of the community.

Second, to address how this CoP model can be supported through technology given the particular needs of the design disciplines in HE **(RQ1a)**, this work drew on the VCoP framework guidelines (see Table 14) by Wenger, White and Smith (E. Wenger et al., 2009). In particular, the configuration strategy for the digital setup of the CoP was guided by the following criteria to: a) to maintain tools that were *similar to those already* used in the organic community b) to avoid complications associated with the use of *proprietary software* (i.e. technology limitations, permissions, cultural characteristics, technical literacy), due to the diversity in the cross-organizational membership, and c) to use *free* or *affordable* web-based technologies that could be easily and flexibly adopted by all CoP members, as well as transferrable beyond university settings, to extend the life of the community, if needed. The intended technology configuration comprised tools for productivity (Google Drive, Google Docs), communication and networking (email clients, Facebook Groups, chat), creativity-support (Adobe Suite, ConceptBoard, Axure), embedded website feedback (Hypothes.is), online showcase platforms (Behance), and learning management systems (Moodle).

Finally, through the analysis of the technology adoption (**RQ1b**), the study found that *awareness* of others' *identity* (i.e. users roles), *space* (i.e. position on canvas) and *time* (new / complete activities), are critical dimensions for enabling efficient team collaborations, particularly in synchronous visual CSTs. From a CoP-wide perspective, virtual spaces should facilitate various *integrated* media channels (audio/video conferencing, chat, screen sharing etc.), multiple user roles and activity privileges, and importantly, *interoperability* with popular services such as social networks and online libraries, and to support access to common (user) data and functionality, without the need of separate software.

Based on the above, the study has extracted a set of guidelines for the design or evaluation of CoP technology configurations in the HE Design disciplines. These have been integrated within the *guidelines model* and can be found in chapter 9.

4.7 Summary

This chapter presented the first *study* in phase 1 - *Design & Implementation* - which concerned the technology (Set) component of a cross-organizational CoP ecology, appropriated to the needs of the HE Design studies.

The study explored the technology configuration *setup* of the CoP and reported on the its type and level of adoption by learners. It provided a rich description of how the community's *orientations* were mapped onto the WDD *epistemic process model*, in order to define the technology requirements for the CoP practice. It then described the *technology acquisition strategy*, which took into account the needs, as well as the challenges faced in configuration designs which are targeted for cross-organizational CoPs.

Following these steps, the gradual *technology adoption* investigations (i.e. formative data collection processes throughout the semester) that took place, allowed the detection of positive and importantly, certain *limiting* factors, that led to necessary *run time reconfigurations*, to enable effective *social* and *epistemic* processes. As the ACAD framework asserts, the learning phenomena that surface within the three components (technology, social, epistemic) of concern, are interrelated and interinfluenced, and thus warrant *timely monitoring* and *adjustment* to ensure that the learning objectives are met.

As such, the contribution of this study through the design and empirical validation of the technology configuration, provides guidance for others who wish to integrate this type of CoPs in their learning environments. The specific platforms and tools may not be appropriate across all fields of Design, and may become outdated in time, yet the inherent epistemic needs and respective methods, are of value regardless.

From a technology perspective, findings indicated that the respective configuration was – to its largest part – able to support the field's epistemic needs efficiently. All the same, problematic adoption observations were analyzed and factored into the *design guidelines model*, presented in 10.2.2. Still, further investigation is needed to understand the *epistemic processes* and *outcomes* of learners, in order to begin forming a compound idea of the role of cross-organizational CoPs in Design education. As such, the next chapter presents study **2** of phase 1, which reports on the perceived *epistemic cognition* and *outcomes* of students who participated in the CoP.

5 Phase 1 – Study 2: Investigating the Role of CoPs in Epistemic Cognition and Creativity

Study **2** of phase **1** investigates the impact of participation in the cross-organizational CoP on the learners' *epistemic cognition* and *creative* outcomes. The study draws findings from the academic results of two groups of students (experimental and control group), to detect any significant statistical differences in their outcomes, in terms of their conceptual *knowledge* gains (via a final exam), and the *creative quality* of the websites they developed. While these quantitative findings serve as good indicators of impact based on aggregates and comparisons, according to Wenger (Farnsworth et al., 2016), the participant perceptions and insights can help explicate the experiential aspects of learning, which are critical for understanding the causes behind such positive, negative or neutral outcomes related to CoPs. As such, the study constitutes in fact, a validation of the epistemic design of the CoP ecology within the Design studies in HE. Results from this study are currently under review in the *Internet and Higher Education* journal.

5.1 Introduction

The modern creative and knowledge economies have transformed employment prospects significantly, in that basic labor competencies have been replaced by expectations of higher-order thinking skills (L. Leung & Bentley, 2017; Mourshed et al., 2014). New graduates must think innovatively and also be able to transfer and apply knowledge to come up with creative solutions that are suited for real-world contexts (Mourshed et al., 2013).

That said, although crucial, creativity is often overlooked in HE, since it is perceived difficult to cultivate and complex to measure (Allee, 2000; Hildreth & Kimble, 2004; V. R. Lee, 2014). The fact that creativity is synonymous with the creation of innovative and appropriate outcomes in response to real-world problems or goals, makes *authenticity* an important constituent of creativity in education (Amabile, 1982; Furnham et al., 2011; Kaufman & Baer, 2005; Runco & Jaeger, 2012). Apart from its real-world association, authenticity in learning comprises the resolution of ill-defined problems, collaboration with professionals, external (integrated) assessment using industry resources and criteria, and the development of useful and polished products (J. S. Brown et al., 1989a; Herrington et al., 2014; Lombardi, 2007). Blending *creativity* and *authenticity* in education can thus produce the kind of graduates with creative capabilities and sound vocational experiences who are currently in demand to implement "economic and innovation growth" on a global level (Albats, 2018; Perkmann et al., 2013). HE programs can be modernized through robust industry alliances, which can in turn support the development of diverse creative skills and processes; these are currently missing from today's industry and are required to achieve innovative outcomes (Edmondson et al., 2012; Mead, 2015; Roodhouse, 2009).

The present study proposes that creativity and authenticity in education can effectively meet within a situated learning context through a cross-organizational CoP, which is integrated into the curriculum (E. Wenger, 1998). Specifically, by bringing together CoP members from academia and industry, the knowledge and skills needed to develop enhanced creative outcomes that are well suited for the real world can be effectively fostered (Albats, 2018; Ivascu et al., 2016).

Research has called for deeper investigations of CoPs' *epistemic component*, and in particular evidence that is hinged on a specific discipline (Amin & Roberts, 2008; A. DeChambeau, 2017; U. Smith et al., 2017). Within the scope of this study, we borrow from the framework of *epistemic cognition* and use its variables to enrich the meaning of the term '*epistemic'* to reflect not only on the tasks associated with learning (Carvalho & Goodyear, 2014a), but also on *how* learning is *co-created* or negotiated between CoP members, *why it holds value* to them, and how *this can be transferred* on to work processes and outcomes (Greene & Yu, 2016; Sandoval et al., 2016).

These variables directly guide the overarching research aim of this study (see Figure 25):

RQ2: What constitutes an appropriate epistemic design for cross-organizational CoPs embedded in HE Design studies, based on the learners' actual and perceived epistemic and creative outcomes?

This is divided in the four sub-questions which follow:

– **RQ2a:** What are the differences in the creative outcomes of learners who participated in the CoP versus those who didn't, as evaluated by external CoP stakeholders?
– **RQ2b:** What are the differences in the conceptual knowledge gains for the learners who participated in the CoP versus those who didn't, based on the final exam scores?
– **RQ2c:** What are the differences in the levels of communication between learners across the two groups?
– **RQ2d:** What are the are the CoP (experimental) group learners' perceptions of their *epistemic cognition?*

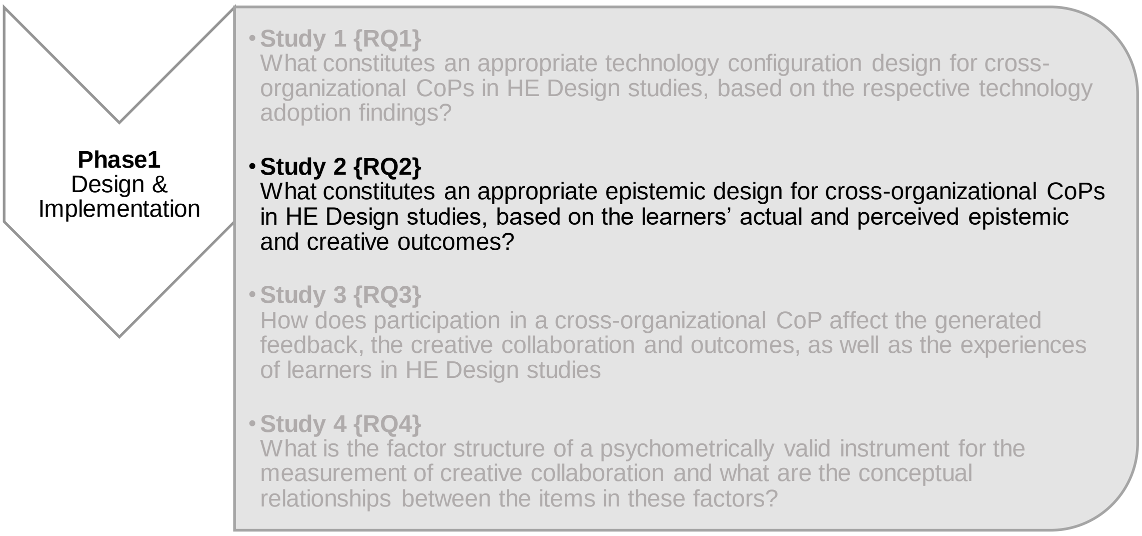


Figure 25: Study 2 overarching research question

5.2 Methodology

The first part of this research adopted a quasi-experimental design for investigating the effects of the cross-organizational CoP on students' creative outcomes and knowledge gains. In the second part, we collected qualitative data to deepen our understanding with insights of the participants' *epistemic cognition* drawing from the experiences of their participation in the CoP.

As such all 38 students from the experimental (G1) and control (G2) groups participated in part 1, while part 2 involved students from the experimental group only (see Table 21).

Table 21: Study 2 participants

Phase	Study	Participant Groups	Semester
Phase 1 Design & Implementation	Study 2: Epistemic design	G1 (N=21) students + G2 (N=17) students + 38 evaluators	Semester 1 (WDD-1)

Data for this study is presented in Table 22 and was collected through:

a) the Web Site Creativity Measurement Instrument (WSCMI) (see section 3.2.9.6) to evaluate the creative quality of the websites produced by the student teams in both G1 and G2 groups. The core evaluation group using the WSCMI to rate the websites included all industrial members of the CoP in addition to graduate students and HCI researchers, as described in section 3.2.9.6. A total of 38 evaluators completed the questionnaire resulting in a total of 317 valid participant responses, b) a final exam at week 15 of semester 1 (see section 3.2.9.7), c) email communication frequencies as indicators of interest and involvement in the lesson and projects (see section 3.2.9.8), d) focus groups with student teams in the experimental condition only, and e) related instructor field notes (see section 3.2.9.1), and e) instructor's notes (see section 3.2.9.3). In the focus group sessions students were prompted to talk about their socio-epistemic experiences. Specifically, based on their shared acquaintance and knowledge (Bloor, 2001), they were initially asked to talk about their roles and collaboration processes in the team (e.g. How did you share the work responsibilities? Did you work concurrently or consecutively? How well did you collaborate with the external members of the community?) and then to openly discuss the factors that contributed - positively or negatively - to their knowledge gains, creative processes and respective outcomes, (e.g. To what extent did interaction with the community affect your creative processes and outcomes – both as individuals and as a team? Are there any differences between this and other projects you have worked on as part of your course?). Students were also asked about resolving issues that had come up during their CoP sessions (e.g. What were the major issues that came up while working with real clients, and being guided by mentors? How did you handle them? How have they affected your creativity, your collaborations and generally what was their impact on you as students/designers?).

The instructor's notes comprised observational remarks that were categorized by week and the recorded topics concerned class-based work processes, creative moments and epistemic breakthroughs in both within-team, group-wide (class), and CoP-wide interactions.

Table 22: Study 2 data collection

Method	**Participants & Sessions**	**G1**	**G2**
Focus Groups	5 teams (x 3 sessions, N=457 min, N=14,357 words)	✓	
Observation notes	Instructor (N=2,396 words)	✓	✓
WSCMI	38 students + 38 evaluators	✓	✓
Final exams	38 participants	✓	✓
Email communication	G1 N=54 email threads G2 N=25 email threads (team-based) G2 N=14 email threads (with alumni mentors)	✓ ✓	✓

5.3 Analysis and Findings

The evaluation scores for learners' creative outcomes (WSCMI) and conceptual knowledge gains (final exam scores) for both participant groups were formatted and imported into SPSS for statistical processing. Primarily, we screened the data for outliers. In the case of the exam scores, this process identified one out-of-range case as an extremely low value (outlier) and was therefore excluded from the sample. Based on the sample size in this case, we further explored the exam scores data to test the normality assumption through a Shapiro-Wilk test, which generated a non-significant result ($W(37) = 0.96$, $p = 0.36$), confirming that the data was normally distributed (Shapiro & Wilk, 1965).

In the case of the WSCMI scores, based on the fact that large samples can be valid for any distribution (Ghasemi & Zahediasl, 2012; Lumley et al., 2002), we proceeded to investigate the instruments' factor reliability (internal consistency) and concluded optimal levels of internal consistency at $\alpha > 0.9$ for all factors (excluding single-item factor 7) (Cronbach, 1951).

In terms of communication frequencies, we recorded the CoP/non-CoP emails (experimental, control conditions) and feedback exchanges in Behance (experimental condition) for further comparisons.

The qualitative data from focus group interviews and instructor field notes were formatted and imported into NVivo for thematic analysis. A subset (20%) of the lengthy dataset was selected based on subject relevance, and were analyzed inductively using an open coding method (Patton, 1990). To derive semantically inclusive inferences with respect to the research aims, we defined text segments of multiple (versus single) sentences as the unit of analysis. We investigated participant and instructor perceptions of concepts relating to *epistemic cognition* and *creativity* in conjunction with CoP participation. Specifically, the derived codes reflected such CoP experiences which triggered epistemic and creative reactions in the learners' processes and outcomes. These are presented in Table 26.

5.3.1 Evaluation of Creative Outcomes (RQ2a)

An independent samples t-test was conducted for each of the seven WSCMI creativity factors to examine mean differences between the control and experimental groups. Following Bonferroni correction for Type 1 error (i.e. alpha level set to .05/7=0.007), statistical differences emerged between the groups across the seven factors, in favor of the experimental group (see Table 23).

Table 23: Comparison of website creativity evaluations' (WSCMI) independent samples t-test for experimental and control groups

	Experimental			**Control**			t	d.f.	P	Cohen's d
	N	Mean	S.D.	N	Mean	S.D.				
Aesthetically appealing design	167	3.89	1.28	143	2.97	1.60	-5.46	271.03	<0.001	0.628
Interactive design	173	4.30	1.20	144	3.30	1.51	-6.37	270.15	<0.001	0.727
Novel and flexible design	173	4.00	1.27	144	2.97	1.50	-6.52	281.67	<0.001	0.742
Affective design	170	3.76	1.30	144	2.73	1.60	-6.21	274.80	<0.001	0.710
Important design	173	4.22	1.17	143	3.47	1.61	-4.66	253.58	<0.001	0.535
Common and simple design	172	3.45	1.31	144	2.81	1.34	-4.23	301.63	<0.001	0.478
Personalized design	173	4.01	1.52	143	3.28	1.72	-3.91	286.39	0.001	0.444
Overall mark	173	5.77	1.67	144	4.34	2.26	-6.31	258.22	<0.001	1.223

The websites developed by the teams in the experimental group received on average (M=4.17, SD=1.34), significantly higher scores than those in the control group (M=3.23, SD =1.64). Following evaluation by external stakeholders, it was confirmed that participation in the cross-organizational CoP was linked to higher quality creative outcomes. The effect size for five of the factors indicates a medium to large effect ($d > 0.6$) (Cohen, 1992), while a medium effect is noted for the other two factors ($d > 0.44$). These values denote an effect of practical importance, in conjunction to the statistical significance of the findings (LeCroy & Krysik, 2007).

5.3.2 Conceptual Knowledge Gains for Learners (RQ2b)

Learner gains in conceptual knowledge were quantified based on final exam scores. Participant scores (N=38) ranged from 31 to 93 (M=61.78, SD=15.44) out of a 100 (see Table 24). An independent samples t-test was conducted to examine mean score differences between the experimental and control groups. A statistically significant difference ($t(35)=-2.33$; $p=.025$) emerged in favor of the experimental group (M=66.95, SD =13.04) compared to the control group (M=55.71, SD=3.92) with a large effect size ($d > 1.167$; see Cohen, 1988). In short, the experimental group outperformed the control group on the knowledge assessment test.

Table 24: Experimental and control group exam scores' independent samples t-test

	Experimental			Control						
	N	Mean	S.D.	N	Mean	S.D.	t	df	P	Cohen's d
Exam scores	20	66.95	13.04	17	55.71	3.92	-2.33	35	.025	1.167

5.3.3 Group Differences in Communication Levels (RQ2c)

Inquiry is a means of accessing expertise from respondents in the community (experts, mentors, instructors and other students) and, as such, it lies at the heart of CoPs (E. Wenger et al., 2009). Literature supports that inquiry correlates with student engagement and learning experiences as it creates multi-level interactions amongst CoP members (D. Randy Garrison et al., 1999; Linnenbrink & Pintrich, 2003). It was therefore important to investigate and compare the frequency of interaction in the experimental and control conditions, as this would be an indicator of the learners' degree of involvement in and commitment to the work.

Multiple forms of blended interactions were recorded, both in the 'team-based' and 'community-wide' (experimental group) contexts. Information was extracted mostly from emails and feedback posts (Behance) (see Table 25). Email exchanges between the teams and faculty (instructor and floating facilitator) in the experimental group (N=147) were double the amount of those in the control group (N=72).

Several communication transactions took place between students (experimental group) and industrial or alumni mentors who were providing feedback on student work. The Behance posts (N=125) contained a total of 9,939 words (M=75 words per post). This is analyzed in detail in chapter 6.

Table 25: Frequency of communication in experimental and control groups

		Faculty members		Alumni mentors			Industrial mentors	
Group	Project	Team emails (threads)	Team emails (unique)	Alumni mentors emails (threads)	Alumni mentors emails (unique)	Behance feedback posts	Client emails (threads)	Client emails (unique)
Exp. (CoP)	1	10	20	3	5	27	8	10
	2	9	23	2	12	21	6	15
	3	9	37	3	13	24	10	24
	4	7	20	2	6	26	1	1
	5	19	47	4	9	27	4	8
	Total:	**54**	**147**	**14**	**45**	**125**	**29**	**58**
Control	1	1	1			n/a		
	2	11	42					
	3	8	16					
	4	5	13					
	Total:	**25**	**72**					

5.3.4 Perceptions of Epistemic Cognition (RQ2d)

Qualitative data from focus groups and related instructor notes were analyzed to derive learner perceptions of *epistemic cognition* as a result of their CoP participation. A subset (20%) of the lengthy corpus, totaling 14,357 words, was selected based on subject relevance and analyzed inductively using an open coding method (Patton, 1990). Three major themes emerged from the analysis of participant experiences. Namely, *Authenticity & Real-World Experts*, *Creative Constraints* and *Prospective Audience* were perceived as the key motivators within the CoP encouraging learners' creative processes and outcomes. The following table presents the three themes and a detailed list of the concepts they comprise, broken down into *trigger* and *reaction* variables. Although the themes overlap to an extent, the variables are categorized based on the theme under which they are more prevalent in (see Table 26).

Table 26: Themes and respective trigger and reaction variables in CoP-based learning

Themes (motivators)	Trigger	Reaction
1. Authenticity & Real-World Experts	1.1. Early industry experience 1.2. Expert mentor's status 1.3. Similar trajectories 1.4. Well-documented feedback	a. Challenged b. Sincerity and commitment c. Increased time and effort d. Better creative process and outcomes
2. Creative Constraints	2.1. Complex, vague or inconsistent requirements 2.2. Delays 2.3. Strict, negative or conflicting feedback 2.4. Missing material and resources	a. Creative problem-solving b. Reformulation of requirements c. Reformulation of design strategies d. Extensive research e. Well-organised collaboration
3. Prospective Audience	3.1. Public judgement 3.2. Professional portfolio 3.3. Industry reputation 3.4. Career potential	a. Changed perception of achievement b. Responsibility c. Quality vs strategic outcomes

5.3.4.1 Authenticity and Real-World Experts

Participants valued the authenticity that emerged through their participation in the CoP. While challenging, the chance to catch a glimpse of the industry in which they hoped to pursue a career, was a distinctly motivating factor for the students. The projects (assigned and supervised by CoP members) bolstered their *sense of commitment*, making them approach their work more seriously, regardless of the strain on their schedules and existing workloads.

> Team E, member: (1.1, a, c)*
> It's real, it's authentic, the point was for us to live the experience (…) we saw ahead in whatever we were doing and now we know how it's going to be. If it hadn't been for them [the CoP members], it would have been less of a challenge… they made it more difficult, but they helped.

Team A, member: (1.1, a, b)	It's challenging! I dealt with the industry while still a student and I approached it more seriously (…) for me, this was motivating.

* parentheses refer to the items in the themes and variables in Table 26

Interaction with *alumni mentors* and *clients* exposed participants to typical Design industry practices. While the CoP exchanges were challenging to navigate (compared to their usual university projects), students ultimately found them beneficial in light of the creative processes and outcomes that were made possible. Students reported that in the case of the alumni mentors, benefits were grounded in the valuable, *authentic* and well-supported feedback from real-world experts who were on similar *trajectories* to theirs:

Team A, PM[2]: (1.1, d)	It helps [the creative process]… I believe that it is much better, because we get to experience new and more professional practices.
Team C, member: (1.2, 1.3, a, b, d)	To have someone who graduated having done the same studies as you as your mentor is truly beneficial [for the work process and outcomes]. They have been through all of this and they know.
Team B, PM: (1.2, 1.4)	People leave comments on Instagram too – but it's different when it's coming from an expert who supports and documents your work!
Team A, member: (1.1, 1.4, d)	[Referring to the quality of the outcomes] I would not be able to create everything on my own [without the CoP feedback] and I would have had the illusion that I was doing well…

[2] Project Manager

5.3.4.2 Creative Constraints

Participant responses revealed interesting evidence about the role of constraints in creative performance. In this study, participation in the CoP had presented *constraints* in the form of complex, vague or *inconsistent requirements*, delayed responses to students' questions, extensive feedback and design directions, as well as missing resources and material.

The role of constraints was a key discussion point with participants, specifically as to whether these inhibited or enabled their creativity. Ultimately the consensus was that such limitations enhanced the teams' creative problem-solving processes:

Team C, PM: (2.1, 2.2, a, c)	Whatever steps we did at the beginning we needed to revisit afterwards… [for example] … She [the client] considered it ok and wouldn't send any comments [on time], so we would move on… but then she would send something like 'I don't want this' and we had already moved on… so we went back (...) and we invested double the effort.
Team B, PM: (2.2, 2.3, a, c)	I experienced the difficulties of the industry and I got a taste of that (…) and it was very positive for me [referring to creative problem solving].
Team C, member: (2.1, 2.3, a)	[The constraints imposed by the client] sometimes encourage you to be creative… it is better because you have a basis (a frame) to work from.

With regards to missing material, one key incident was recorded in the instructor's field notes, in which Team C reacted by recreating the client's corporate identity and redefining all associated elements (i.e. web color palettes, typography, layout):

Team C, member: (2.4)	Basically, they don't have a logo and they don't know anything about their color scheme!

This new evidence resulted in a reformulation of the original requirements and hence the team's design strategy. They also researched similar case studies online (2d) and contemplated different approaches to address the missing material issue. They also found that they needed to work in a more organized manner as a team in order to avoid compromising the project's quality and deadlines, i.e. they tried to stay on track with their level of *creativity* on the one hand, and the *timing* of their deliverables, on the other. As such, the constraints obligated students to get involved in additional loops of creative problem-solving and decision making:

Team D, member: (2.3, b, c)	They gave us feedback on our work… and then we started to think about it, and we started to review ideas in order to change things.
Team D, PM: (2.3, a, b, c, e)	[Referring to critical CoP feedback] … you should be open-minded enough to change [the design plan], as your goal is to produce something good and not get stuck on your own ideas.[as a result, the team changed their design plan] (…) We took two days and changed it completely!

5.3.4.3 Prospective Audience

It was clear that the CoP had created key prospects for the students in terms of a) the end-audience of their work and b) other potential benefits (i.e. reputation and career opportunities). The students thus valued the prospects resulting from the relationships developed in the CoP, which acted as a push for their *learning commitment* and work *creativity*. The prospect of their website 'going live' (i.e. being published) had an overall transformative effect on their attitude toward the project. The possibility of real, *public 'judgement'* pushed them to work more creatively, instead of pursuing a more strategic, grades-driven approach, which is often the case in traditional academic assessment conditions. It was widely agreed that even if the work was not ultimately published, a real-world project, assigned by real clients and guided by real industry experts, which would feature in their resume and work portfolios, held great value in itself.

Team A, member: (3.1, b, c)	[They were more creative because]… it's different to know that it's a university project that won't end up anywhere, but with this one [the real project] you know that there is a chance it will go live and people will see it and you will be judged (…) you will have the responsibility.

Likewise, students found that they had reframed their prior *perceptions* of *achievement* according to the new standards that were (explicitly and implicitly) communicated through the CoP. As a result, they expressed their motivations in developing better, standard-compliant websites, that could enrich their portfolios, help build a reputation in the industry and generate prospects for professional collaborations:

Team A, PM: (3.2, 3.4, a, c)	It was a push for me to work more creatively and develop something that is up to their standards… well, at least as close as possible to these standards (…) I want to become a web designer, and these are professional companies… and this is my portfolio that I am building… so for me this was motivating.
Team B, PM: (3.2, 3.3, 3.4, a, c)	[We were more creative because of] the fact that we had to deliver something to a potential client or future collaborator… it's a good process, urging us to work better (…) and also

end up with a real-world project in our portfolio.

5.4 Discussion

The objective of this study was to investigate the impact of a cross-organizational CoP on student learning outcomes. Specifically, the study aimed to measure the CoP's effect on the participants' *epistemic cognition*, through quantitative analysis of their creative outcomes (websites produced – RQ2a), knowledge gains (final exams - RQ2b), frequency of communication (RQ2c), as well as through the qualitative analysis of their perceived *epistemic cognition* variables (RQ2d). Aside from the *knowledge* itself (RQ2a and RQ2b), these variables refer to *how* the knowledge was co-created, the *justification* of why it constitutes knowledge and the *ways* in which it *is or can be transferred* (Greene & Yu, 2016; Sandoval et al., 2016). The present work discusses and reports on these variables (RQ2d) as follows:

Co-created knowledge

Through comparison of a control versus an experimental group (CoP condition), the study elicited significantly better results for participants in the latter, in terms of both the learners' creative outcomes (websites) (RQ2a) and knowledge gains (exams) (RQ2b). Both indicate a medium to large effect, which suggests that this difference in student outcomes is meaningful and bears practical implications, especially for instructors and researchers who are interested in improving their learning designs through CoPs (LeCroy & Krysik, 2007).

These outcomes link back to two epistemic cognition variables, primarily, the *knowledge* itself, as well as the *transfer* and integration of that knowledge into the work, that is, the websites produced by students who were members of the community.

How knowledge was co-created

The higher frequency of team communication in the experimental versus the control condition, especially in the category of email exchanges with faculty members (instructor, floating facilitator, students) (RQ2c), indicate greater levels of interest and engagement in learning in the experimental condition (D. Randy Garrison et al., 1999; Linnenbrink & Pintrich, 2003). Overall, the volume of communication threads and feedback between the external members and students in the CoP (experimental condition) reflect the epistemic cognition factor of *how knowledge is co-created.*

Data from the focus groups confirm this too. Although considered laborious, participants commented on the value of learning from the systematic expert reviews and feedback, as well as the chance to experience the practices of real-world experts and clients in authentic projects. This is evident in the *Authenticity and Real-World Experts* theme. As such, the informal knowledge-creation processes in the CoP augmented the learners' formal learning processes and gains. Such cross-organizational "constellations" (E. Wenger et al., 2009) of practices are at the core of innovative learning; since knowledge which is highly situated in certain contexts (i.e. industry) moves beyond its traditional boundaries, is negotiated by the various members of different practices (i.e. education) and enriches them with new value (Tsoukas, 2002).

How knowledge was justified

Analysis presented in both the *Authenticity and Real-World Experts* and *Creative Constraints* themes provides strong evidence of *knowledge justification* episodes, in other words, indications of why learners decided that the information that was exchanged and negotiated in the CoP interactions (mostly in the form of feedback), was reliable and valuable (Conee & Feldman, 2004; Greene & Yu, 2016).

In their testimonies, students stated that they critically evaluated a) the feedback content: they often verified this content by researching and checking against theoretical sources and by investigating similar cases online, therefore engaging in a systematic inquiry and justification process, and b) the feedback contributor: as reported, the contributors' credibility depended not only on their status and expertise, but also on the evidence and documentation they provided to back their feedback. The students reported making respective judgements about the veracity of this information, and in fact stated the superiority of these over other types of feedback - such as those posted on public forums and social networks - based on how well the contributors had documented and justified their reviews (Murphy et al., 2012).

How knowledge was transferred

As reported in the *Creative Constraints* theme, every 'limitation' introduced by CoP members ultimately boosted creative problem-solving activity; teams had to make sense of complex, ill-defined or inconsistent requirements, strict, negative or conflicting feedback, missing material and delays. In response, teams had to interpret and often reformulate the project requirements, rethink their design strategies and streamline their collaboration processes to maintain both the quality and timing of their deliverables. The practical constraints imposed by the CoP in fact helped students to *use* these to their benefit and enhance their creative activity instead (Hofer & Bendixen, 2012; Onarheim, 2012).

In addition, CoP-derived constraints had the effect of gradually transforming learner *perceptions of achievement* (and associated criteria) and encouraging them to use these new insights to guide their work. This was prominent in the *Prospective Audience* theme. In effect, these newly reformed views of what constitutes achievement inclined students to become more responsible in their learning, adopting a quality (performance-driven), rather than a strategy-driven (grades-based) approach to their objectives. This was not only initiated by the prospect of having their work scrutinized and evaluated by the wider community (Lave & Wenger, 1999a), but also the urge to create a strong professional work folio, a solid industry reputation and promising career opportunities, all of which emerged as a result of their participation in the CoP. In effect, the CoP placed these learners one step closer to the industry's expectations, particularly were *creativity* was concerned, while still at university.

The study has analyzed and provided evidence of the positive effects on learners' *epistemic cognition* that can be achieved via participation in a cross-organizational CoP. The findings are significant: while knowledge fluctuates and may often become obsolete, the skill of determining how to co-create and negotiate knowledge, what sources of knowledge are of value, and how to manage and transfer this knowledge, within the context of specific disciplines, and across multiple practices, is critical.

5.5 Summary

This chapter presented the second study in phase 1 - *Design & Implementation* - which looked into the learning *outcomes* and *perceptions* of students as members of the CoP versus non-members. The study analyzed and provided evidence of the positive effects on learners' *epistemic cognition* (knowledge outcomes, ways of knowing, justification, and transfer) that can be achieved via participation in a cross-organizational CoP.

The encouraging findings allowed for a first-time proof of the CoP's positive effects on the *epistemic* outcomes, compared to traditional learning environments. It also revealed the key triggers (incidents, phenomena, stakeholders) behind both positive and negative epistemic reactions, so as to inform others (i.e. instructors, researchers) to proactively pursue or avoid these in future implementations of the cross-organizational model.

As these triggers are critically entangled with the *social* dynamics and *epistemic* activities and outcomes in the CoP, and are also inherently complex due to their cross-organizational nature, they warrant more targeted investigation and analysis. The following chapter focusses on exploring the *socio-epistemic* interactions of CoP members, through the lens of *creativity* as well as *feedback*, which constitutes a fundamental component of the cross-organizational CoP collaborations.

6 Phase 1 – Study 3: Exploring Feedback and Creative Collaboration in a Cross-Organizational Design-Based CoP

Study **3** of phase **1** explores the role of *feedback*, as a fundamental component of the *social collaboration* in a cross-organizational Design-based CoP, on the perceptions, processes and outcomes of students in HE. It specifically looks into the *creative outcomes* (websites) of students, their perceptions of their teams' *creative collaboration*, the type of *feedback* that emerged through their CoP-wide interactions, and the overall *experiences* of students concerning all of the above. These represent an entangled set of variables that must be examined jointly, so as to generate a holistic and more precise understanding of the findings.

The study approaches its investigation from multiple angles, both through *self-reported* and *externally scored* results (running comparisons between the experimental and control groups), as well as related *qualitative* evidence to triangulate findings and thus augment the research's inferences and trustworthiness.

Results from this study have been published in the *Thinking Skills and Creativity* journal (Mavri et al., 2020a).

6.1 Introduction

Creativity is presently the cause of much movement in educational research, as it is crucial not only in the arts, but also in seemingly disparate areas such as the domains of science and engineering (Crilly & Cardoso, 2017; Cropley, 2015; Oh et al., 2013). It nevertheless remains particularly important for the *digital creative industries* that, as previously discussed (see section. 1.1), are intrinsically associated with the production of innovation (Wijngaarden et al., 2019). Creative and innovative outcomes aim for both novelty and appropriateness for real-world problems, which makes *authenticity* a crucial factor in all creative activity (Amabile, 1982). As previously mentioned, *authenticity* in learning, involves ill-structured problems, interdisciplinary settings, active ties and collaboration with experts in the field and—crucially—industry-driven criteria to guide the work and its evaluation (Grohs et al., 2018; Herrington, 2009; Lombardi, 2007).

Social collaboration is also crucial in driving *authenticity* in learning, especially in the digital creative domains where teamwork is dominant (Becker et al., 2017; L. Leung & Bentley, 2017; Nguyen et al., 2016). There is evidently much scope to analyze the learning phenomena that occur within this type of CoPs within specific disciplines (U. Smith et al., 2017).

As such this study explores how *collaboration* and *creativity* evolve through social participation in the cross-organizational CoP. It investigates the creative collaboration processes and outcomes of students in a blended learning setting as participants in the CoP. The role of technology is thus crucial for both *team-based* and importantly, *community-wide* collaborations between stakeholders who are geographically and temporally dispersed.

Special emphasis is placed on understanding the nature of *feedback*, particularly in such Design-based CoPs (Cummings et al., 2016; Popescu, 2014). Feedback is critical, due to the fact that it's strongly associated with the practice of the *Design disciplines* (i.e. architecture, engineering, HCI, computer science), where critiquing and reviewing is fundamental in the development of innovative work (Adams et al., 2016; Huet et al., 2007).

This study is thus guided by the following overarching research aim (see Figure 26):

RQ3: How does participation in a cross-organizational CoP affect the generated feedback, the creative collaboration and outcomes, as well as the experiences of learners in HE Design studies?

This encloses the following sub-questions:

- **RQ3a:** What are the effects of participation in a cross-organizational CoP on the (perceived) *creative collaboration* processes and the (actual) *outcomes* of learners?
- **RQ3b:** What is the nature of the *feedback* that typically emerges in cross-organizational CoPs in the HE Design studies?
- **RQ3c:** How is community-wide collaboration *experienced* and processed by the learners in the CoP?

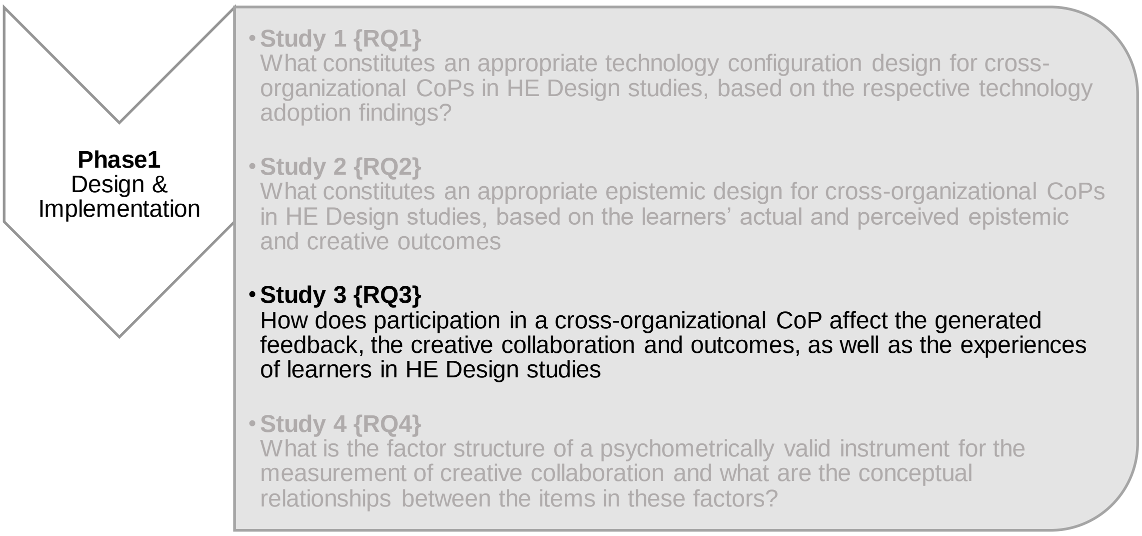


Figure 26: Study 3 overarching research question

6.2 Methodology

This study followed a multi-method approach, drawing from self-reported and actual data to make research inferences, with either the total sample of 38 students (experimental and control groups), or the 21 students of the experimental group (G1) only (see Table 27).
It employed: a) the ASCC instrument (see section 3.2.9.5) to extract individual student perceptions of their team-based *creative collaboration* both at the beginning and the end of the semester (pretest-posttest), b) the WSCMI instrument (see section 3.2.9.6) to gather expert evaluations of the websites produced by students at the end of the semester, c) the *feedback* threads generated on Behance (see section 3.2.9.4) between students, *alumni* and *industrial mentors* throughout the semester (N=132 posts, 9,977 words, *M*=75 words per post), d) 15 during and after-class focus group sessions which were supplemented by instructor notes (see section 3.2.9.1), and e) 10 post-intervention interviews with representative members of all teams at week 13, to derive *individual* views and eliminate team-oriented biases (10 participants, time N=253 minutes of recordings) (Gill et al., 2008).

During the semi-structured focus groups and interviews, students were asked to elaborate on their socio-epistemic experiences in the Cross-organizational CoP. Specifically, they were probed about the ways that feedback impacted their work processes (i.e. *How has the feedback influenced your team activities?*), whether it had positive or negative effects on their individual and team-based creativity - both in the processes and outcomes (i.e. *To what extent did interaction with the community affect your creative processes and outcomes?*), how it was addressed (i.e. *How did you address the feedback and the issue it caused?*), their perceptions of the feedback's correctness and credibility (i.e. *Do you agree with the feedback you received and why?*), as well as their own opinions of their work's value (i.e. *Following your CoP exchanges and the feedback you received so far, how would you evaluate your work?*).

The ASCC and WSCMI instruments were used as part of a quasi-experimental approach with both the experimental (G1) and control (G2) conditions, while the *feedback* posts and *focus groups* concerned students in the experimental (G1) condition only. Furthermore, the WSMCI was employed with 24 graduate students and 4 HCI researchers – in addition to the CoP's 10 industrial members - as evaluators, to ensure sufficient diversity and objectivity in the results. These are presented in Table 28.

Table 27: Study 3 participants

Phase	Study	Participant Groups	Semester
Phase 1 **Design & Implementation**	Study 3: Social design: creative collaboration, outcomes and feedback	G1 (N=21) students + G2 (N=17) students + 38 evaluators	Semester 1 (WDD-1)

Table 28: Study 3 data collection

Method	Participants & Sessions	G1	G2
Focus Groups	5 teams (x 3 sessions, N=457 min, N=14,357 words)	✓	
Interviews	10 participants (N=253 min, N=8,095 words)	✓	
Observation notes	Instructor (N=2,396 words)	✓	✓
ASCC	38 students (pre-posttet)		
WSCMI	38 students + 38 evaluators	✓	✓
Behance feedback posts	5 teams, 3 alumni mentors, 5 industrial mentors (N=101 posts, 9,977 words)	✓	

6.3 Analysis and Findings

6.3.1 Evaluation of Creative Collaboration (RQ3a)

The ASCC questionnaire was administered to students in both conditions (N=32) at the start and the end of semester 1. Participants were advised to respond, based on their most recent collaborative projects in the pretest, and on their actual semester project experiences in the posttest cycle. Pretest results had no significant statistical differences between experimental (M=5.60 , SD=0.84) and control (M=5.57, SD=0.38) group scores; $t(31)=-0.12$; $p=.89$).

For the postest cycle, Cronbach's Coefficient Alpha's for each of the three factors of the scale, provided the 0.89, 0.77 and 0.75 values respectively, which suggest satisfactory internal consistency (Lance et al., 2006). By employing a series of t-tests and applying Bonferroni correction, there were no differences in the ASCC scores between experimental group (M=5.08, SD=1.48) and control group (M=5.85, SD=1.15) ($t(27)=1.65$; $p=.2$) in the posttest cycle. These findings indicate that participation in the cross-organizational CoP did not have a significant impact on the learners' perceptions of their teams' creative collaboration.

6.3.2 Evaluation of Creative Outcomes - WSCMI Scores (RQ3a)

A total of 317 *website evaluation* ratings were analyzed in order to derive findings as to the creative value of the websites produced by students teams (experimental versus control conditions). We began by investigating the internal consistency of the scale. Cronbach's coefficient alphas for each of the seven factors of the scale ranged from 0.87 to 0.97, which suggests a high internal consistency.

Independent *t*-tests resulted in statistical differences with medium and large effects (Cohen, 1992). Overall, creativity ratings for the experimental group's websites (M=4.17, SD=1.34) were significantly higher than the control group's (M=3.23, SD =1.64) after Bonferroni correction for Type 1 error (i.e., alpha level set to .05/7=0.007) (see Table 29). This provides evidence that social participation in the cross-organizational CoP produced significantly better creative outcomes for learners compared to those participating in traditional HE curricula.

Table 29: Comparison of website creativity evaluations - independent samples t-test for control and experimental groups

	Experimental			Control			t	d.f.	P	Cohen's d
	N	Mean	S.D.	N	Mean	S.D.				
Aesthetically appealing design	167	3.89	1.28	143	2.97	1.60	-5.46	271.03	<0.001	0.628
Interactive design	173	4.30	1.20	144	3.30	1.51	-6.37	270.15	<0.001	0.727
Novel and flexible design	173	4.00	1.27	144	2.97	1.50	-6.52	281.67	<0.001	0.742
Affective design	170	3.76	1.30	144	2.73	1.60	-6.21	274.80	<0.001	0.710
Important design	173	4.22	1.17	143	3.47	1.61	-4.66	253.58	<0.001	0.535
Common and simple design	172	3.45	1.31	144	2.81	1.34	-4.23	301.63	<0.001	0.478
Personalized design	173	4.01	1.52	143	3.28	1.72	-3.91	286.39	0.001	0.444
Overall mark	173	5.77	1.67	144	4.34	2.26	-6.31	258.22	<0.001	1.223

6.3.3 Feedback in Community-Wide Collaboration (RQ3b)

For RQ3b, we looked at the nature of feedback as this emerged in the CoP. Feedback posts submitted over the 13-week semester were downloaded and imported in NVivo for content analysis. Two researchers analyzed the data using priori coding (Saldaña, 2015) based on Cummings et al.'s (2016) coding framework (see Table 30); a random sample (12%) of the data was screened for inter-rater reliability, producing a "substantial" level of agreement of k = 0.76 based on Cohen's Kappa coefficient, according to Viera & Garrett (2005).

The recorded units were defined by the meaning of each statement (sentence or paragraph), while employing a continuous approach (allowing for multiple classifications of text in more than one code when the data required more than one interpretation), rather than a dichotomous one (mutually exclusive) (Weber, 1990). Overall, the process resulted in a total of 1,235 references, split into the *Focus*, *Type* and *Tone* categories. No new codes emerged as the data was fully described by the coding scheme. The prevailing category codes were 'Form' (Focus category), 'Direct Recommendation - verbal' (Type category) and 'Negative' (Tone category) (see Figure 27).

Table 30: Feedback coding frequencies

	Instances	Percentage
FOCUS	376	30.4%
FOCUS\Form	252	20.4%
FOCUS\Function	115	9.3%
FOCUS\No Code	4	0.3%
FOCUS\Representation	4	0.3%
TYPE	517	41.9%
TYPE\Brainstorming	41	3.3%
TYPE\Comparison	19	1.5%
TYPE\Direct Recommendation – Verbal	240	19.4%
TYPE\Direct Recommendation – Visual	0	0
TYPE\Free Association	3	0.2%
TYPE\Identity Invoking	0	0
TYPE\Interpretation	32	2.6%
TYPE\Investigation	29	2.3%
TYPE\Judgment	151	12.2%
TYPE\Process Oriented	2	0.2%
TONE	342	27.7%
TONE\Negative	183	14.8%
TONE\Neutral	94	7.6%
TONE\Positive	65	5.3%
Total	1235	

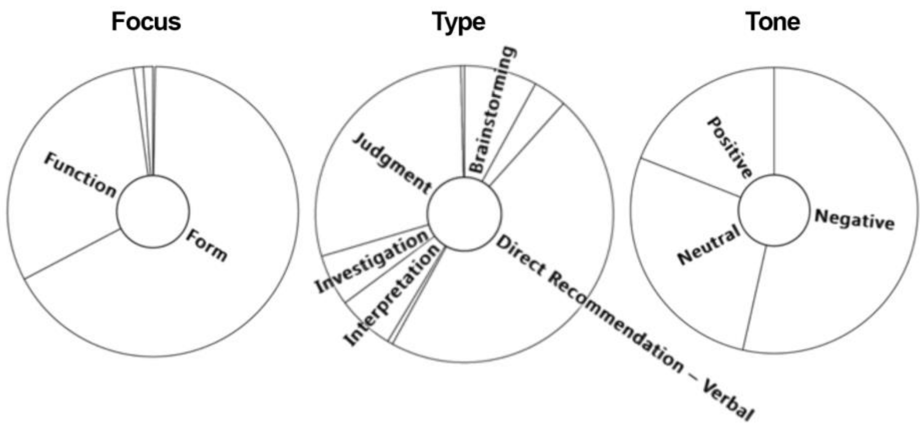


Figure 27: Coding references hierarchy charts

6.3.3.1 *Interactions Between Creative Outcomes (WSCMI) and Feedback (RQ3b)*

Following the analysis of the *website evaluations* (WSCMI) and *feedback,* we were interested to uncover possible interactions (i.e. correlations) between the two, as the they both represent *actual* forms of *socio-epistemic* data. Guided by related bibliography on the effects of positive and negative feedback on learners' self-beliefs and ensuing performances (see section 2.2.5.3) we were particularly interested in the *Tone* dimension of the feedback results. A Pearson coefficient was computed to assess their relationships. No correlations were found between *positive* feedback and WSCMI scores (see Table 31). However, a significant negative correlation was found between *negative* feedback and WSCMI scores [r=-0.859, n=21, p<.01].

Table 31: Multiple correlations between feedback *tone* and website evaluation scores (WSCMI)

		Feedback positive	Feedback neutral	Feedback negative	WSCMI scores
Feedback *positive*	Pearson Corr.	1	.414	-.161	-.318
	Sig.		.062	.485	.160
Feedback *neutral*	Pearson Corr.	.414	1	$-.773^{**}$	$.640^{**}$
	Sig.	.062		.000	.002
Feedback *negative*	Pearson Corr.	-.161	$-.773^{**}$	1	$-.859^{**}$
	Sig.	.485	.000		.000

Specifically, *negative* feedback appeared to be a significant predictor for lower website creativity scores, while the reverse (*positive* feedback) was not applicable. This suggests that while the experimental teams' creative outcomes were higher (compared to the control group), they could have been further improved following a more moderate - versus a harsher - approach to feedback from the CoP's industry members. The data also indicates that *neutral* comments, the majority of which fall under the 'Direct Recommendation' type (see Table 32) were positively correlated with WSCMI scores (r=0.640, n=21, p=.002) (see Table 31). This indicates that constructive reviews and expert advice delivered in plain, rather than negative, tones can yield improved outcomes.

Table 32: Coding frequencies based on feedback type and tone

Tone	Negative		Neutral		Positive		
Type	instances	%	instances	%	instances	%	Total
1. Direct Recommendation	140	27.3%	77	15.0%	23	4.5%	240
2. Judgment	93	18.2%	8	1.6%	50	9.8%	151
3. Brainstorming	13	2.5%	18	3.5%	10	2.0%	41
4. Interpretation	19	3.7%	7	1.4%	6	1.2%	32
5. Investigation	14	2.7%	14	2.7%	1	0.2%	29
6. Comparison	13	2.5%	4	0.8%	2	0.4%	19

6.3.4 Experiences of Feedback in Community-Wide Collaboration (RQ3c)

As previously mentioned, *feedback* in this study was found to mostly come in the form of ‘direct recommendations’ expressed in a negative tone. We were interested to understand and triangulate these findings by examining the qualitative data from the focus groups and post-intervention interviews with students, as well as the supplementary notes from the instructor.

The data was analyzed using inductive thematic analysis, based on a ‘reflexive’ approach, which focuses on extracting the *essence of meaning*, with a primary aim to draw substantial conclusions on the phenomena under study, by taking into account the involvement and subjective role of the researcher in the analysis (Braun et al., 2019b). Specifically, we aimed to uncover evidence on the students’ experiences of community-wide *collaboration* and *feedback,* as well as on perceptions of their *creative outcomes*, and consequently any possible interactions between the two. Following multiple rounds of reviewing and data saturation, the analysis yielded three main themes: a) *Feedback volume, time pressure and learning regulation*, b) *Feedback tone, self-concept and renegotiation of learning & achievement* and c) *Feedback focus, complexity and metacognitive activity*. The structure of each theme is based on the: a) *causes* (i.e. the collaboration incidents), b) *effects* (i.e. how these were received), and c) *actions* (i.e. how they were addressed or applied as a result). The three themes are discussed in the following sections.

6.3.4.1 Theme 1: Feedback Volume, Time Pressure and Learning Regulation

The majority of student comments on feedback found *time-pressure* as a prevalent factor in their CoP-based collaborations; they reportedly felt somewhat overwhelmed by the reviews and had to dedicate time and effort to understand and process the feedback in order to act upon it:

Team B PM[3]:	They gave as a lot [of feedback], you need a lot of time, at least three hours each time to analyze what they say (…) it's like 2000 words!
Team B member:	You get lost [in managing the volume of feedback] at some point…
Team C member:	He [alumni mentor] gave us too many comments!

Inevitably, the large volume of comments forced team members to engage systematically with the project and be more accountable, allowing less room for "free-riders" (Saghafian & O'Neill, 2018). Students actually commented on their increased motivation to improve in response to the feedback:

Team D member:	[after receiving extensive feedback that required many changes] (…) within a couple of days, we all worked on it much more and we changed it completely!
Team B member:	[commenting on the extensive feedback] If you get to the point that you can manage the comments – it's really very good for us.

While highly valued by students, feedback gradually became burdensome. The projects advanced into phases with complex deliverables, which in turn generated lengthier and

[3] Project Manager

more elaborate revisions from the external CoP members. The students' receptivity to feedback dropped during these stages and there were noticeable signs of friction between members, who were all trying to balance their workload against new requirements. The effect on their schedules was at such times perceived as hindering the teams' creative performance:

> Team C PM: I believe that if we didn't have so much time pressure [as a result of the feedback], we would be much more creative.

Despite perceptions of compromised creativity, *feedback* and *time constraints* did in fact spark collaborative amendments which led to creative outcomes (i.e. the websites), assessed as significantly better for the affected teams (Biskjaer et al., 2019). This aligns with existing literature which confirms that moderate time-pressure and tension are precursors to effective collaboration, as they result in deeper engagement, better negotiations and improved creative problem-solving practices (A. DeChambeau, 2017; E. C. Wenger & Snyder, 2000). Likewise, students reported incidents as attempts to fine-tune and regulate their work processes in order to counteract these delays:

> Team C PM: Three of us worked independently, in parallel with the other two until now [referring to the more advanced project stages], but now we need to break the [roles and tasks] down even further I think…
>
> Team C member: Yes we don't have any other option now (…) it's also easier to communicate and reach consensus with two people [rather than three or more, following the delay from the extensive feedback].

Other than reconfiguring roles and tasks, they also explored tools that could help them achieve their goals faster, without compromising the desired quality of the design deliverables (Schoenfeld, 2016):

Team C member: The tool that we used to plan the schedule saved us an unbelievable amount of time compared to Excel [they searched for different software to speed their work processes up in response to the feedback-induced delays].

Clearly, the amount of feedback 'squeezed' the teams' timeframes, and urged them to revisit their work practices to enforce new, 'just-in-time' actions as part of an enhanced co-regulated learning process (D. R. Garrison & Akyol, 2015).

6.3.4.2 Theme 2: Feedback Tone, Self-Concept, Transformed Learning and Re-negotiation of Achievement

Feedback tends to be negative by nature, more often than not: its objective is to identify parts of a work that warrant attention and propose means of improvement (Hyland & Hyland, 2001; Värlander, 2008). In this study, feedback comprised mostly 'direct recommendations' (*process-oriented*) rather than plain 'judgements' (*task-oriented*). That said, direct recommendations may have been used as a good mitigation strategy for "sugar-coating" negative remarks (Hattie & Timperley, 2007). The analysis indicated that some of the student work was subjected to harsh criticism, which often reflects the culture of the real-world practice in the Design fields (Flynn, 2005; Hokanson, 2012). Team members were thus concerned and became invested in resolving such feedback-oriented issues. When they sought the instructor's opinion, they were prompted to make their own judgments and follow up with actions - in other words act autonomously. They subsequently researched relevant theories to verify the credibility of the negative reviews or to collect enough evidence to support counter propositions. Such theoretical sources might have otherwise been overlooked or learned by rote for the purposes of formal assessment (i.e. exams). Yet in this case, students were investigating the theories with a genuine interest to back their design prerogative:

Team C PM: The theory we went through yesterday about complementary colors? He [the

alumni mentor] commented on that and we thought "oh… we should have thought about that; we should have done this ourselves!"
[Instructor's notes: students then proceeded to investigate the matter further to understand and act according to the feedback instructions.]

(…) We now wrote these as guidelines down and we really hope they will help us again in the upcoming project phases.

While rigorous feedback may have generated significant *corrective* activity, it also brought the work's weaknesses and gaps into focus. As a result, students often questioned their self-worth. This was also clear through their self-assessment, which at times, veered towards the critical:

Team C PM: [Following negative feedback] It is discouraging when you spend all this effort to design and set it all up (…) it is not the best result that we could produce, but we did all we could.

It became apparent that the new, demanding criteria that came in negative tones enforced the teams to reform their self-concepts and re-negotiate their perceptions of achievement accordingly:

Team C member : We see how it is now [in terms of achievement and success based on real industry criteria] when we'll leave university… not how we imagine it but how it actually is in reality.

Team C PM: [In the absence of the CoP's feedback] I would not have been able to do everything on my own, and I would have had the illusion that I am doing well!

Additionally, one of the key ways in which the feedback resonated was that students identified themselves with its originators. As the majority of the posts were submitted by *alumni mentors* who 'navigated' similar trajectories to theirs, the students perceived the comments they delivered to be of value:

Team D member : [The feedback] really matters when you have the same background [as the alumni mentors], you think alike and the difference just lies in their professional experience.

Overall, these incidents denote that the learners' self-concept was pragmatically negotiated through their CoP membership, which exposed them to the real-world practice. Lacking experience, learners would typically judge their performances more leniently, as a result of "naïve, over-confidence" (Gehlbach et al., 2008; Gormally et al., 2009). Instead, the CoP feedback triggered a degree of disillusionment in the learners, who renegotiated the meaning of achievement with regards to the wider community (industry).

6.3.4.3 Theme 3: Feedback Focus, Complexity and Metacognitive Activity

Collaboration with external CoP members often involved inconsistent and ambiguous feedback. This was to be expected, as the members came from different practices, with varying degrees of knowledge and expertise and different personal expectations from their CoP membership (Culver & Bertram, 2017). The impact of receiving feedback, which was at times ambiguous, was twofold. Some learners took this as a chance to make more autonomous decisions, while others raised objections, saying the feedback was too difficult to follow (Zajonc, 1980). While the feedback was broad, in that it focused on several diverse dimensions of the work (i.e. visual, technical, usability, marketing/promotional), it often lacked structure, coherence and specificity. Its ambiguous nature often gave a sense of freedom and the opportunity to engage in enhanced creative activity:

Team D PM :	You can have better creative results if you are not pressured [through client feedback] and they give you more space (…). But when he is lecturing all the time and micro-manages you, at this point you just do the work mechanically in order to get it done.
Team A	[When students were asked to comment on how creative they were] The client's requirements were poor so this gave us flexibility to design the prototypes (...) and take initiative!

At other times, such feedback was somewhat *disorienting*, particularly when it contained contradictory comments. This is, in fact, an authentic phenomenon which is highly representative of the real-world practice, especially in the case of professional teams who follow a *user-centered* design approach. Opinions from multiple stakeholders (i.e. users, clients, management) may be conflicting at times, and yet need to be critically judged and factored into the work, following collective assessment and informed decision-making by the design team (Marcolino et al., 2014). Based on this, students expressed concerns over the impact this had on their team creativity:

Team B PM:	Creativity is compromised by *conflicting opinions* (i.e. when one likes it and the other doesn't), in the course of development as these disturb [the creative] momentum.
Team E member:	(…) it's confusing. They had totally opposing opinions… one of the mentors told us that it [the website prototype] was

> quite good in terms of layout (…) while the other said she got lost, she had no idea where she was and what she could do [on the website]!

The feedback interactions also highlighted the *complexities* of the cross-organizational collaboration. Specifically, the students had to dedicate extra effort to understand and decide what to do in response to feedback. They meticulously scrutinized the large body of comments and communication notes, closely reflected on those, and compared them against the newer work developments (additions, modifications). As mentioned in the previous theme (see 6.3.4.2), they likewise researched theoretical and empirical sources (i.e. forums), to judge their next steps. This indicated deep forms of collective *meta-cognitive activity*, which aimed to assess the team's *understanding*, their contributors' *opinions*, the *value of the work* produced and the respective *propositions* about the following course of actions (retain, reject or aggregate opinions) (D. R. Garrison & Akyol, 2015; Veenman et al., 2006).

6.4 Discussion

The present study reported on the effects of participation in a cross-organizational CoP, integrated in formal HE on related learning phenomena. Specifically, these included the perceived *creative collaboration* (ASCC) processes and the actual *creative outcom*es (WSCMI) of learners (**RQ3a**), the nature of *feedback* as a central component of community-wide collaboration (**RQ3b**), and the learners' *experiences* with regard to all the aforementioned variables (**RQ3c**).

Based on the diverse set of variables under investigations, we deemed necessary to organize the discussion section in two parts, explicitly, the *creativity* and *feedback* related parts of the discussion.

6.4.1 Theoretical and Empirical Inferences From a *Creativity* Evaluation Perspective

This study measured two dimensions of creativity, namely the processes and the outcomes of learners who participated in the cross-organizational CoP versus those who didn't, through score-based testing. Specifically, following pretest-posttest administration of the ASCC, no significant differences were found in the perceived *creative collaboration* between the two groups; in fact, the experimental group's scores were slightly lower to those of the control group in the posttest. In this sense, participation in the CoP had no positive effects on the perceived *creative collaboration* of its members. That said, the website creativity scores extracted through the WSCMI, were significantly higher for the same students (CoP members) compared to non-CoP-members. Based on these findings, we turned to qualitative evidence, in order to explain the somewhat unexpected relationship of the *perceived* versus the *actual* outcomes of learners. Through this, we were able to detect both, the positive influences of the CoP, as well as the challenging experiences of the students who participated in it. These were evidently "efficacy-altering experiences" (Tierney & Farmer, 2002), challenging the students' individual or collective *self-beliefs*, and thus their '*creative self-efficacy'*. As this phenomenon was linked to community-wide collaboration and *feedback* – to be exact, it is also addressed in more detail in the feedback-related part of the discussion that follows (see section 6.4.2).

With regards to creativity, and aiming toward its rigorous assessment (in the case of creativity outcomes), the study recruited a diverse range of expert stakeholders to evaluate the creativity of websites produced by students at the end of the semester. The individual and often diverse perspectives of these stakeholders expanded the breadth of *social judgment* on creativity. According to theoretical conceptualizations, the appropriateness or creative value of a product can only be defined through *social judgement* that materializes within a given context (Amabile, 1982; P. B. Paulus & Nijstad, 2003; Sawyer, 2011). The appreciation of creativity in this sense, lies in the *eyes of the beholder*; based on specific societal and historical characteristics (background, purpose, needs, limitations), and the ways that these shape the user experience at the *time* of his/her interaction with a product (Csikszentmihalyi, 1988; Horn & Salvendy, 2006).

Additionally, in this study, the CoP membership offered a 'window' into the collective development processes for the majority of evaluators (i.e. alumni and industrial mentors). This generated opportunities to formatively review the learning activities (especially those in response to *feedback)* that led to creative outcomes, to construct a more rounded understanding of the creative processes. This provided key contextual information such as the social environment, the roles and divisions of work, the tools and materials used, the procedures followed and the ways that time was managed.

We argue that these two elements (social judgement, systemic creativity evaluation) of the guided practice constitute a fundamental contribution of the cross-organizational CoP model to the type of education which aims to foster creativity. The overview and evaluation of creativity in learning, was not restricted to the summative, single-assessor (instructor) approaches, that may evidently detach traditional pedagogy from the real-world practice (Boud & Falchikov, 2006; Carless & Boud, 2018; Loizides et al., 2019). Instead, it offered a diversified degree of *social judgment – in* measuring creativity objectively and authentically, in both formative and summative ways, contributing towards a more systems-based approach to the evaluation of creativity.

This study thus coincides with new theoretical perspectives that try to move away from notions of creativity as an isolated attribute of *people*, *products or processes* alone. Instead, the enhanced creative outcomes inferred (WSCMI), were processed together with interconnected process-oriented findings (ASCC), and related *experiential* insights, to form a more holistic picture of creativity and related learning phenomena (**RQ3a**). The study approached creativity as entangled with and *distributed* in the interactions of CoP members, in their dealings with various artifacts, at the intersection of cultural contexts (university, industry), and along a continuum (CoP practice), as part of an integrative research approach (Glăveanu, 2014; Hennessey, 2017).

6.4.2 Theoretical and Empirical Inferences from a *Feedback* Perspective

With regards to community-wide collaboration, this study aimed to report on the nature of *feedback* that is most inherent in cross-organizational CoPs in the HE Design disciplines (**RQ3b**), and to explore the ways that this was perceived and processed, being a key element of social Design-based collaboration (**RQ3c**) .

The feedback submitted by expert CoP members over a 13-week period (semester 1) was content-analyzed and categorized under the dimensions of *focus*, *type* and *tone*. The findings indicated that the prevalent codes were: a) *Form* (in the *Focus* category) which refers to the design attributes of the work, b) *Verbal Direct Recommendation* (in the *Type* category), which refers to advice and suggestions for work enhancements, and c) *Negative* (in the *Tone* category), which refers to the tonality of the reviews. As mentioned, qualitative data informed the study with the leaners' experiences of their CoP-wide collaboration and, therefore the *feedback* that was generated through this (**RQ3c**). The analysis indicated that *feedback* (positive or negative) was the underlying cause for better *creative outcomes* **(RQ3a),** as it caused team breakdowns that created motive for enhanced learning regulation, *meta-cognition* and the renegotiation of learning and achievement perceptions for students, as CoP members. This finding is consistent with previous work, asserting that such perceived barriers can urge learners to reconsider their progress and regroup accordingly (Fischer & Bell, 2004).

Further, the analysis also inferred that a) *extensive* feedback of b) a particularly *negative tone* and c) an *ambiguous* or conflicting foci, imposed considerable time-pressures, raising the degree of *complexity* and reducing the students' *self* or *collective efficacy* as a result (see section 2.2.5.1). This finding also agrees with previous work on self-beliefs, suggesting that exposure to unfamiliar, demanding circumstances and harsh feedback (i.e. based on industry-level criteria) can challenge learners' beliefs of their abilities and outcomes (Chong & Ma, 2010; Gehlbach et al., 2008; Tierney & Farmer, 2002). Conversely, teams who lack such challenging experiences (i.e. in traditional instruction conditions) tend to perceive their aptitude and performance "quite positively" (P. Paulus, 2001). This aligns well with our findings and help explain the slightly lower creative collaboration (ASCC) scores of students in the experimental versus the control groups (see section 6.3.1). Based on such findings, we assert that the link between *feedback* and self-beliefs in HE is an important aspect of learning in cross-organizational CoPs, with much scope for further investigation.

We also posit that this is not a negative result, but rather, a promising one. As suggested by learners themselves, gaining familiarity and knowledge of the challenging industry practices constitutes a valuable experience and triggers further regulatory activity, even if it feels frustrating while it's happening. From this aspect, we also see how the industry-academia CoP experience transformed learners' perceptions, as prospective graduates and young professionals, capable of tackling messy real-world problems (Albats, 2018; Grohs et al., 2018). Through their *legitimate peripheral participation* in the CoP, students were gradually exposed to critical information about the real-world practice and generally, the conditions, criteria and prospects of the broader community, while still at university. The meaning of achievement was repeatedly questioned and negotiated throughout their membership, following the *paradigmatic trajectories* and accomplishments of more competent others (E. Wenger, 1998). In this study, we deduce that this is a process of pragmatic realization or 'grounding', that causes a reformulation of learner identities. It seems to occur when knowledge of a subject and its domain expands beyond basic subject-level knowledge, triggered by the authentic interactions and 'glimpses' into the real-world geography of practice (E. Wenger-Trayner et al., 2014). This in fact enables novices to position themselves within this geography and helps renegotiate their goals in order to get there. This awareness of the self in relation to the broader, real-world domain constitutes a key 21st century skill of "living in the world" (Binkley et al., 2012). It is therefore apparent that the cross-organizational CoP model makes a significant contribution to the area of learning and development in the context of Design and related studies in HE and hope that this work will guide further research and practice with similar goals.

6.5 Summary

This chapter presented the third *study* in phase 1 - *Design & Implementation* - which offered a well-rounded understanding of the *social* community-wide *creative collaboration* phenomena and the resulting *creative outcomes*, by placing special emphasis on *feedback*. Its findings contribute useful insights and directions for researchers, educators and designers who wish to implement, participate in, or evaluate the cross-organizational CoP model in their learning spaces, with a focus on enhancing the creative processes and outcomes of students.

The study employed two scoring-based instruments, namely, the WSCMI and the ASCC, to extract quantitative creativity results, and by this, to also provide others with the means to measure creativity in a fast and flexible manner. However, as the original ASCC instrument was not systematically assessed, we proceeded to validate the instrument prior to its use, in an aim to enhance the validity of this research. The next chapter provides an extensive report of the assessment procedure of the instrument's psychometric properties.

7 Phase 1 – Study 4: On the Reliability and Factorial Validity of the Assessment Scale for Creative Collaboration

Study **4** of phase **1** delivers an initial validation of the psychometric properties of a self-reported instrument, the Assessment Scale for Creative Collaboration (ASCC) that measures learners' perceptions of the *creative collaboration* in a team, within CSCL contexts. The study was conducted in order to support the research objectives of study 3 (see section 6) which employed the ASCC to derive such findings.

Results from this study have been published in a short paper, in the *IFIP Conference on Human-Computer Interaction* 2019 proceedings (Mavri et al., 2019b). More extensive information on the study's research processes can also be found in a full paper version which was published in the *International Journal of Human–Computer Interaction* (Mavri et al., 2020b).

7.1 Introduction

Creativity can evidently provide a competitive advantage for today's graduates and enhance their employment prospects as they transition into the innovation-oriented digital industries (Turbot, 2015). Yet, the creativity field appears significantly under-researched (Batey, 2012), with the bulk of present research largely focusing on the organizational sphere, while creativity in education - particularly in the areas of Design, HCI, and engineering – has yet to be the focus of exhaustive and targeted investigation (Frich et al., 2018).

As a multi-dimensional construct, creativity has always been challenging, especially in identifying the elements required for its effective practice and – importantly its *evaluation*, especially within technology-supported contexts. The role of technology does in fact represent a new dimension and adds further complexity to the investigation of creativity.

Various evaluation approaches, such as observation, automatic data extraction, external assessment, neurobiological examination, self-reported and other score-based testing, have aimed to capture such different dimensions of the construct over the years (Amabile, 1982; Batey, 2012; Horn & Salvendy, 2006; Meneely & Portillo, 2005; Plucker & Renzulli, 1999).

This study has a particular focus on score-based approaches for creativity, which are typically used for evaluating *stimuli* in *real-life* situations (Gouvier & Musso, 2014). However, literature denotes that the majority of these tests, focus on the *individual* dimension of creativity, with the 'Torrance Test of Creative Thinking' (TTCT) [(Torrance, 1966) and the 'Kaufman Domains of Creativity Scale' (K-Docs) (Kaufman & Baer, 2005) posing as key representative examples. Based on relevant research, we posit that the assessment of creativity in *collaborative* endeavors, is still under-explored (see section 2.7.2.1). What still remain missing from literature, are instruments that can be used for the assessment of *social collaborative or distributed* creativity, in natural settings (i.e. classroom, online). Such instruments are critical, as their opposites, these being, controlled lab-based (*in-vitro*) investigations, come into conflict with the ill-structured and exploratory nature of creativity (Frich et al., 2018; Shneiderman et al., 2006).

As such, this study seeks to derive a *psychometrically valid* scale for the evaluation of *collaboration* and *creativity*, by using an existing instrument, the Assessment Scale for Creative Collaboration (ASCC), as the main deliverable of the European-funded CoCreat Lifelong Learning Project (Wishart et al., 2011).

The ASCC (see section 3.2.9.5) measures the principal variables of *creative collaboration*, as these are perceived by coworkers in blended learning settings, underpinned by the *CSCL* and *creativity* theories (Dillenbourg et al., 2009; Ferrari et al., 2009; Fischer & Shipman, 2013b; Lew et al., 2013). The authors explain the term '*creative collaboration'* as the "collaboration process between people, working on collective tasks in the creative or other industries" (Wishart et al., 2011). The initial 25 items of the scale measure the *creative processes* that stem from *ill-defined problems*, which initiate cycles of *imagination*, *divergent thinking* and *problem-solving*, that transpire through the learners' *interest* and *engagement* in a task. It also suggests that learners need to draw from *prior subject-level knowledge* and withstand *time pressures*, in order to develop *novel* and *appropriate* outcomes.

The scale lends itself as a flexible method of measuring creative collaboration in teams of learners. While the scale's reliability values were reported at an earlier stage of the project, its psychometric properties had yet to be assessed. This study is thus guided by the following overarching research question (see Figure 28):

RQ4: What is the factor structure of a psychometrically valid instrument for the measurement of creative collaboration and what are the conceptual relationships between the items in these factors?

This encompasses the following sub-tasks which aim to extend the original work by:

- **RQ4a:** Determining the ASCC's subscales (factors) and presenting their reliability values
- **RQ4b:** Interpreting and analyzing the conceptual relationships of the subscales' variables, guided by background work.

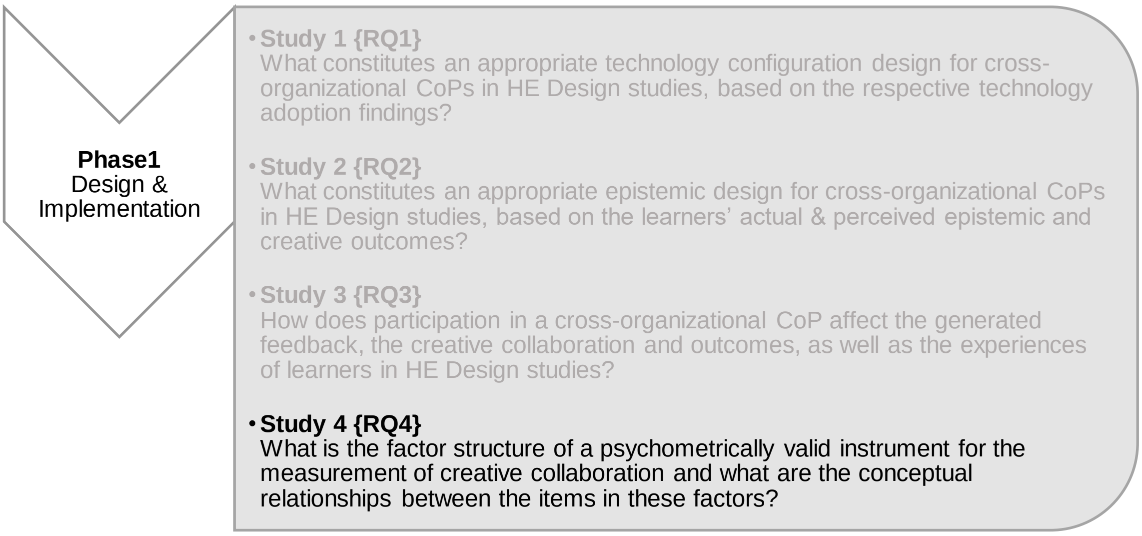


Figure 28: Study 4 overarching research question

7.2 Methodology

A total of 236 undergraduate and postgraduate students (see Table 33), with recent sufficient collaborative work history, completed the ASCC's questions using a 7-point Likert scale. The participant sample falls close to the ten observations-per-item approach, which indicates a 'fair to good' analogy (Barlett et al., 2001; Gorsuch, 1983; R. H. Pearson & Mundform, 2010). Participants were prompted to consider their most recent collaborative experience as part of their academic responsibilities, for completing the questionnaire.

Table 33: Study 4 data collection information

Phase	Study	Participant Groups	Semester
Phase 1 Design & Implementation	Study 4: ASCC reliability & factorial validity	236 local/international undergraduate & postgraduate students	Semester 1 (WDD-1)

7.3 Analysis and Findings

7.3.1 Parallel Analysis

We conducted Parallel Analysis, prior to factor analysis, to identify the statistically significant factors (eigenvalues) to be obtained from the scale (O'connor, 2000; N. D. Wood et al., 2015). We used a permutation approach for running the Parallel Analysis (PA), as it is reportedly a more appropriate and robust method for multivariate non-normal data. A three-factor structure, agreeing with the eigenvalue of >1 criterion (Kaiser, 1960), was extracted from the 25 variables of the questionnaire.

7.3.2 Exploratory Factor Analysis (EFA)

Descriptive statistics presented an average range of item means of 4.26 – 5.92 (M=5.29) and ample diversity in opinions (SD=1.46). EFA was conducted, using the Principal Axis Factor (PAF) extraction method on the ASCC's variables, which were expected to be correlated - a typical phenomenon in social studies. The Kaiser-Meyer-Olkin measure of sampling adequacy was found to be of an optimal value of ,913. The Bartlett's test of sphericity, for the homogeneity of the correlation matrix (Scott, 2015) was found to be significant ($\chi2$ (300) = 3117.52 p < .001). The three factors obtained (see Table 34) accounted for 47,28% of the total variance in the ASCC variables. Extracted factor eigenvalues and total variance percentages were: Factor **1**=9.084 and 36.33%, Factor **2**=1.672, and 6.68%, Factor **3**=1.065 and 4.26%.

A within variables approach indicated that the variables have a moderate to high level of common variance based on the extracted communality values: >.5 accounted for the 48%, >.4 accounted for the 40% and the rest for values of <4. The rotated pattern matrix (pattern coefficients) results indicated an initial set of eleven variables for Factor 1, seven variables for Factor 2, and seven variables for Factor 3. We retained variables with the following criteria: a) a pattern coefficient of 0.4 and above and b) significant differences in cross-loading values (approximately ≥ 0.20) (Netemeyer et al., 2003).

Table 34: Scale dimensions, descriptions and individual items

Dimension 1	Synergistic Social Collaboration	Theoretical Origin
A 9-item subscale that assesses social collaborative learning and the conceptual variables of interest and emotional factors such as belonging, mutuality and trust		
Group interest in the task	1. Everyone in our group was interested in the task.	Interest
Trust between participants	2. Classmates/colleagues in my group trust each other.	Social Collaborative Learning
Orientation towards the task	3. Everyone in my group wanted to make a successful product.	Interest
Safe atmosphere	4. We had a feeling of belonging together.	Social Collaborative Learning
Communication	5. We were all able to express our ideas, even controversial ones, freely.	Creativity
Discussion of ideas	6. We were able to share and discuss our ideas with each other.	Creative Collaboration
Level of collaboration	7. We understood each other's viewpoints at the start of the project.	Social Collaborative Learning
Adequate knowledge base	8. Our group had the necessary knowledge to be able to complete our task.	Social Collaborative Learning
Shared knowledge and goals	9. I had a good idea of what the others in my group knew that is relevant to this activity.	Interest
Dimension 2	**Distributed Creativity**	**Theoretical Origin**
A 7-item subscale that assesses collective divergent thinking and externalization, the degree of tension and perceived co-presence in distant teams		
Problem boundaries stretched or broken	10. We weren't always certain about how to carry out the task which led us to explore different possibilities.	Creativity
A degree of disagreement or tension	11. We sometimes disagreed, but we discussed our different points of view.	Creativity
Group-based time pressure	12. My group was pressured to complete in time.	Time Pressure
Degree of co-presence (formally - text based)	13. We were able to share information between group members e.g. via a wiki or shared document.	Interest
Possibilities for externalizing representations	14. We could see or find out what other people knew or were thinking about. For example, we could draw, write or build things on the computer that the other group members could see and/or read	Creativity
Degree of co-presence (informally - SN)	15. We were able to chat informally with the other group members via text or social networking.	Interest
Level of divergent thinking	16. My group generated diverse and novel ideas in response to the task.	Creativity
Dimension 3	**Time Regulation and Achievement**	**Theoretical Origin**
A 5-item subscale assesses the degree of individual and collective time-management as components of learning regulation and achievement		
Stretching boundaries	17. We went beyond the set task.	Creativity
Group-level time management	18. Our group organized our time for learning well.	Time Management
Individual time management	19. I organized my time for learning well	Time Management
Emotional expression	20. The set task/activity enabled us to express our emotions.	Social Collaborative Achievement
Level of imagination	21. Between us we used a lot of imagination	Creativity

Qualitative judgements about the retention of variables were made during post-PAF-processing. With the exception of items 2, 4 and 7 in Factor **1**, the rest cross-loaded on other factors, but were maintained due to their compliance with retention criterion (b). Factor **2** loaded with a total of seven items. Item 16 failed the retention criteria, but was retained due to its critical conceptual significance related to divergent thinking. Factor **3** loaded with a total of seven items, out of which two did not match retention criteria and were thus dropped from the instrument. Factor **3** resulted in a total of five variables.

7.3.3 Reliability Analysis

Following FA, we proceeded to investigate the three subscales' internal consistency/ reliability and expected the following: a) a Cronbach's alpha coefficient minimum of $\alpha = 0.70$ for the subscales (Cronbach, 1951) (the minimum value of 0.7 is acceptable for newly developed scales (Lance et al., 2006)), b) Inter-item correlations ranges of 0.3 and 0.7 to indicate homogeneity but no redundancy (Pett et al., 2003), c) small inter-item correlations standard deviation, preferably ≤ 0.1 (Pett et al., 2003) and finally, d) a minimum value of 0.4-0.75 for corrected item-to-totals as indicated in the item-total statistics results (Netemeyer et al., 2003). These are presented in Table 35, while individual reliability results for each sub-scale are outlined in the following three sections.

Table 35: Initial Reliability Statistics for the ASCC Subscales

	Cronbach's alpha	Mean inter-item correlations	SD of inter-item correlations	No. of items
Factor 1	.924	.695	0.01	11
*Updated**	.893*	.654*	0.00*	9*
Factor 2	.778	.505	0.01	7
Factor 3	.758	.529	0.01	5

7.3.3.1 Subscale 1

This subscale presented an optimal level of internal consistency at $\alpha = 0.92$ (Cronbach, 1951). Most items fell within the inter-item-correlation ranges, apart from three items, which were above the value of 0.7. A closer examination in conjunction with the item-to-total correlation results, indicated that two out of three were far higher than the recommended upper limit and were therefore deleted. Item 1 was retained as a key conceptual variable of ‘interest’ within the subscale. A second reliability analysis, resulted in a lower (updated*), but still high, Cronbach’s value of $\alpha = 0.89$ (see Table 35).

7.3.3.2 Subscale 2

Reliability analysis of its seven items concluded an acceptable value of Cronbach’s $\alpha = 0.77$ (see Table 35). This subscale presented an item (12) that failed to meet the minimum criteria, in a few of the inter-item-correlation ranges. Based on the fact that it measures ‘time pressure’, a key conceptual element inherently linked to creativity and collaboration, the variable was retained.

7.3.3.3 Subscale 3

Reliability analysis of the subscale’s five items concluded an acceptable Cronbach’s value of $\alpha = 0.76$ (see Table 35). Item 20 scored just below the minimum value of 0.3 in the inter-item-correlation matrix (0.29). It was nevertheless retained in the subscale due to its critical theoretical significance (see Table 34). As all subscale coefficients resulted high alpha values ($\alpha \geq 0.70$), the scale presents high internal consistency.

7.4 Discussion

This study undertook an initial validation of ASCC’s psychometric properties (**RQ4a)** in response to an increasing need for instruments for the assessment of the social dimensions of creativity in HE team-work settings. The EFA resulted in a three-factor scale, with a total of 21 items measuring ‘Synergistic Social Collaboration’, ‘Distributed Creativity’ and ‘Time Regulation and Achievement’. Their analysis and interpretations is provided in the following section (**RQ4b)**.

Subscale 1: Synergistic Social Collaboration

The choice of term for this subscale relies on the role of *synergy* amongst collaborative team members in the production of greater results than the mere sum of separate individual parts. This nine-variable subscale contains factors of co-present computer-supported, as well as distant collaborative learning (CSCL) (Gaggioli et al., 2015; P. B. Paulus et al., 2012). It includes a number of *affective* variables, such as the sense of belonging, mutuality and trust between participants, as well as *cognitive* variables, such as the ability to develop a shared understanding of individual viewpoints within a group (see Table 34).

The persistent recurrence of *interest* as an intrinsic motivational variable is anticipated, as it appears strongly intertwined with literature on *collaboration* and *creativity*. With both affective as well as cognitive traits, the construct of *interest* and *engagement* is linked to conceptualizations about one's self, as well as the related social, physical, and conceptual aspects of the context (i.e. 'Shared knowledge and goals') (Wentzel & Miele, 2009). Eccles'(1983) expectancy-value model denotes *interest* as a fundamental component of its *task-value* factor (i.e. the perceived worth of an academic task), as well as the force that drives the successful *completion of tasks* (i.e., 'Orientation towards task success') (Wigfield & Eccles, 2000). This is supported by the high correlation value between the two variables, 'Group engagement' and 'Task Success' (r = 0.664).

Further theoretical associations confirm the structure of this subscale. For example, as *interest* and *engagement* grow, learners and collaborators in a field become naturally more inquisitive and explorative ('Discussion of early ideas'), leading to further generation and analysis of ideas. The 'Discussion of early ideas' is clearly a significant stage in creative and collaborative learning processes. The ASCC report posits that this variable, typically related to *brainstorming* activities, is explicitly linked to *collaborative creativity* literature (Mamykina et al., 2002).

Similarly, 'Adequate knowledge base' is regularly encountered across theoretical domains. A sufficient level of domain-specific knowledge is projected by Amabile (1982) in her *componential theory of creativity* and is also a primary variable, rooted in social constructivist learning theories (Vygotsky, 1978), and a vital precursor to higher-level *cognitive* functions involved in collaboration (C. S. Huang et al., 2016). Prior knowledge is also strongly connected to interest and engagement in this subscale (r = ,550), and across the literature (Linnenbrink-Garcia et al., 2012).

Subscale 2: Distributed Creativity

Drawing from Sawyer's and DeZutter's (2009) definition, this seven-item subscale is labeled 'Distributed Creativity', as the majority of its variables relate to the concept. Creativity is presented in the form of original ideas or products of the team-oriented

‘Level of divergent thinking’, which *are suitable for a purpose* (i.e. ‘My group generated different and novel ideas in response to the task’). This type of collective creativity is heightened in response to *ill-defined* problems, that lack explicit directions for their resolution, by augmenting and advancing the creative thinking processes (‘Problem boundaries stretched or broken’). Furthermore, a moderate ‘Degree of disagreement and tension’ within a respectful and trustful context is a positive precursor to collective generation of *divergent thinking*. This is supported by the high correlation value between ‘Degree of disagreement and tension’ and ‘Level of divergent thinking’ (r = 0.452). A ‘Degree of disagreement or tension’ in the form of argumentative exchange can also enforce reflective reasoning during a collective task (Wishart et al., 2011). *Tension* in itself denotes evidence of engagement and interest, which is included in the ‘Degree of co-presence’ variable in the subscale.

Another point of interest is the positive relationship between *time pressure*, and creativity, which is evident in the subscale. This relationship appears to work in various ways according to literature. Studies have shown that working under pressure may impede creativity, by leading participants to choose faster and safer - rather than more exploratory and time-consuming - options (Amabile et al., 2002). That said, working under *mild-to-moderate time pressure* is a “challenge stressor” (Prem et al., 2017) that can be beneficial, by triggering creative effort and motivation.

In terms of *co-presence* – both *formal* and *informal* – apart from the foreseen inter-item correlation amongst the two (r = 0.544), we were able to elicit that a ‘Degree of (informal) co-presence’ is associated with ‘Externalizing representations’ (r = 0.473), and the latter also correlates with the ‘Level of divergent thinking’ (r = 0.476), making this the second-highest correlation in the sub-scale. The link between creativity and *externalization* in social collaboration is key (Vyas et al., 2009), particularly in the of Design disciplines. Specifically, the process of using physical or digital artifacts such as paper sketches, texts or 3D-prototypes to portray thoughts on to tangible objects is used for communicative, coordinative, explorative and reflective activities (Zurita et al., 2016). These require a high degree of *co-presence* amongst team members, which is made evident through the high inter-item correlations between the two variables in the subscale.

Finally, the subscale demonstrates good inter-item correlations between ‘Group-based time pressure’ and ‘Stretching problem boundaries’ (r = 0.463), while the latter also correlates well with a ‘Degree of disagreement or tension’ (r = 0.443) (see Table A6). We notify the reader that ‘Stretching problem boundaries’ refers to the exploration of different possibilities, as opposed to ‘Stretching boundaries’ in subscale 3, which suggests surpassing the assigned task deliverables.

Subscale 3: Time Regulation and Achievement

The title of this factor stems from the positive interaction between *learning regulation* (with time regulation as a key sub-construct) and *achievement*, based on relevant literature (Pintrich, 2004). ‘Time regulation and Achievement’ is a subscale comprising five variables. As anticipated the highest inter-item correlation (r = 0.636) in the subscale appears between ‘Individual’ and ‘Group-level time management’. *Time-management* and its three dimensions, *self-regulation*, *co-regulation* (pairs) and “socially shared regulation” (Hadwin et al., 2011), appear as key constituents of *learning regulation* in literature (Pintrich, 2004; Stoeger & Ziegler, 2008). Social regulation reveals well-planned collective strategies, concerning time and effort, in purpose of attaining individual or collective knowledge and goals (Romero & Barberà, 2012).

Further, behavioral research illustrates the connection between *regulation* (‘Group time-management’) and *innovation*, as an accomplishment that surpasses the original expectations (‘Stretching boundaries’) (Britton & Tesser, 1991; Pintrich, 2004). Knowledge of self-ability, the purposeful planning of steps towards an end-goal, and adhering to that plan, through the systematic monitoring of timely activities (Hirst et al., 2009) is fundamental in achieving and transcending the end-goal (‘We went beyond the task’). These two variables also presented good inter-item correlations (r=0.463) in the subscale. Additionally, ‘Group time management’ is also positively correlated with the ‘Level of imagination’ (r = 0.435), a term associated with *divergent thinking* and *creativity*, in related literature too. Specifically, daily planning, confidence of long-term planning, total *time-management* and perceived control of time and tenacity, are traits of creative individuals or teams that regulate their practice in aim of innovative performances (Darini et al., 2011; Zampetakis et al., 2010).

Finally, existing research posits that 'Emotional expression' is closely linked to regulated learning, due to its significance in the orientation and commitment of individuals or teams, towards an end-goal (Prem et al., 2017). Sound socio-emotional workspaces have the capability to promote creativity, cultivating feelings of *trust* and *inter-connectedness* amongst participants. Reversely, negative environments, with a restrictive and distrustful feel, can impede the levels of emotional expression, natural communication, experimentation, and can subsequently lead to poor creative outcomes (Valiente et al., 2012). 'Emotional expression' has a relatively low but positive correlation with achievement ('Boundaries Stretched') in this subscale.

7.5 Summary

This chapter presented the fourth and final *study* in phase 1 - *Design & Implementation*. The study described in this examined the psychometric properties of an existing instrument (ASCC), by a) determining its factor structure through EFA as well as its reliability values, and b) analyzing and discussing the conceptual relationships amongst the variables under each factor. Future improvements involve the employment of a Confirmatory Factor Analysis to provide additional validity to the instrument.

Its contribution toward the aims of this work and the overall research community, lies in the fact that it constitutes a tool that has so far been absent from literature. We posit that in order to promote creativity in learning, we should have tools at our disposal that can readily frame it, without disrupting the *real situated* conditions it transpires in (versus employing intrusive methods or limiting its investigation to lab-based contexts).

Further, we follow the view that creativity should be holistically investigated. This is true, particularly in the case of this research, which evolves in a *blended* context, bringing together diverse stakeholders, backgrounds and skills through the use of technology, with the aim to deliver innovative work with a real-world impact (Candy, 2013; Glăveanu et al., 2019). As the ASCC partially supports the aims of this work, its findings are triangulated against other methods (observation, interviews, focus-groups) to derive a holistic understanding of the *real situated* learning phenomena that emerge in the context of CoPs.

The next chapter draws from the outcomes of all aforementioned methods, and analyzes them through the lens of the *Value Creation* framework to derive conclusive inferences on the role of cross-organizational CoPs in Design-relevant areas of learning.

8 Phase 2 – Study 5: Value Creation and Identity in Cross-organizational Communities of Practice: a Learner's Perspective

Study **5** constitutes the main body of work of the *Evaluation* phase. It draws from a blend of outcomes from phase **1**, which concern technological, epistemic and social-oriented findings (1st semester), and integrates these with new information collected in the 2nd semester of the research. This blended dataset is analyzed through the lens of the Value Creation (VC) framework (see section 2.5.2), to draw inferences as to the *worth* of *learning* and the transformation of learner *identities*, following CoP participation. *Identity* is a constitutive part of social learning in CoPs, as learning generates an on-going process of 'becoming', reconfiguring the identity through multiple negotiated experiences, of an individual and a collective nature. It is also crucial within the scope of this work, which aims to foster the development of learners' *pre-professional identities* while in university, for the purpose of enhancing their industry transition and employability prospects. Results from this study are currently under review in the *Internet and Higher Education* journal.

8.1 Introduction

This purpose of this study is to evaluate the worth of learning generated through participation in the cross-organizational CoP throughout the entire course of the research (two academic semesters). It also seeks to derive evidence on the effects of this participation on the learners' *identities*, by leveraging the joint learning potential of the university-industry model that is has empirically applied.

To derive results in respect of the abovementioned objectives, it examines the learning processes and outcomes of HE Design students as CoP members, drawing from the research outcomes of phase 1 (semester 1), as well as new and more conclusive evidence from phase 2 (semester 2) of this work. It does so by employing the Value Creation (VC) framework (see section 2.5.2) to guide its analysis. The framework seeks to assess the value of learning that is co-created in the CoP practice, by connecting "specific activities to desired outcomes" (E. Wenger, 2009). For the purpose of clarity, it classifies learning in five distinct cycles, that evaluate the *interactions* of the CoP, the *knowledge capital* co-created, its *transfer* into the practice, the *performance* improvements, and their *reframed* perceptions of *achievement*, as a result.

It then processes these findings to understand the CoP's effects on learners' *identity*. As an integral part of social learning, the investigation of identity can help derive conclusive inferences towards the quest for its viability in today's fast moving industries (E. Wenger, 1998).

This study is therefore primarily guided by the following overarching question (see Figure 29):

RQ5: How does participation in a cross-organizational CoP influence the value of learning, and consequently, the pre-professional identities of learners in HE Design studies?

This incorporates the following research sub-questions:

- **RQ5a**: What types of learning are facilitated through membership in a technology-supported cross-organizational CoP, as classified by the Value Creation framework?
- **RQ5b:** How does membership in cross-organizational CoP impact the learners' identity, as a constitutive part of learning and professional viability

The primary focus of this work is to report its findings, exclusively from a learner's perspective, using the VC framework which investigates phenomena that are predominantly related to learners and learning. While other perspectives (i.e. industry stakeholders') may derive more conclusive inferences of the model's potential, this approach falls under a larger scope of research and is to be investigated in future work.

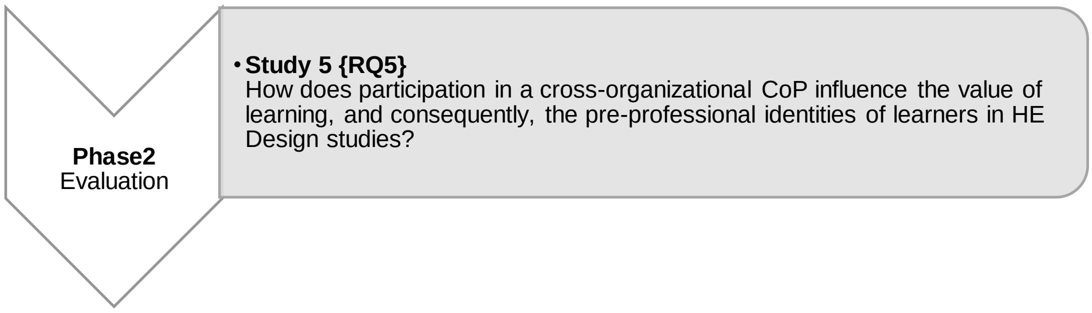


Figure 29: Study 5 overarching research question

8.2 Methodology

This study employed all 38 students from the experimental (G1) and control (G2) groups that participated in phase 1, and only the 21 participants of the experimental group (G1) in phase 2 (see Table 36 and Table 37). For clarity purposes we list the data collection processes under semesters 1 and 2.

We remind the reader of two key points: a) the cross-organizational CoP structure was slightly altered in phase 2 to address the learning needs (learners' perspective) that were extracted through the analysis of data in phase **1** as described in section 3.2.6), and b) this study draws from the data collected and analyzed in studies **1** (see section 4.4), **2** (see section 5.2), and **3** (see section 6.2) from phase **1**, and provides a detailed explanation of the data collection methods and the respective analysis processes in phase **2**.

Table 36: Study 5 participants – phases 1 and 2

Phase	Study	Participant Groups	Semester
Phase 1 Design & Implementation	Study 5: Value Creation & Identity transformation	G1 (N=21) students + G2 (N=17) students + 38 evaluators	Semester 1 (WDD-1)
Phase 2 Evaluation		G1 (N=21) students	Semester 2 (WDD-2)

Table 37: Detailed participant list - phase 2

Participant	Team	Role*	Gender
P1	A	M	F
P2		PM	F
P3		M	F
P4		M	F
P5	B	M	F
P6		PM	F
P7		M	F
P8		M	M
P9	C	PM	F
P10		M	F
P11		M	F
P12		M	M
P13	D	PM	M
P14		M	M
P15		M	F
P16		M	F
P17		M	M
P18	E	M	F
P19		M	F
P20		M	F
P21		PM	F

Table 38: Data collection methods in semesters 1 and 2

	Semester 1 (phase 1)	**G1**	**G2**
Interviews	10 participants (N=253 min, N=8,095 words)	✓	
Focus Groups	5 teams x 3 sessions (N=457 min, N=14,357 words)	✓	
Observation notes	Instructor/interviewer (N=2,396 words)	✓	✓
ASCC	38 students	✓	✓
WSCMI	38 students + 38 evaluators	✓	✓
Final exams	38 participants	✓	✓
Behance feedback posts	5 teams, 3 alumni mentors, 5 industrial mentors (N=101 posts, 9,977 words)	✓	
Email communication	G1 N=54 email threads G2 N=25 email threads (team-based)	✓	✓
	G2 N=14 email threads (with alumni mentors)	✓	
Artifacts in Conceptboard & GoogleDrive	N=1393 (artifacts, chats, notes, boards)	✓	

Semester 2 (phase 2)	
Interviews	8 participants (N=360 min, N=12,717 words)
Focus Groups	5 teams (N=21 participants) x 1 session (N=318 min, N=18,498words)
Observation notes	Instructor/interviewer
Facebook group timeline (SN)	N= 205 posts

8.2.1 Phase 2 Data Collection

We ran semi-structured focus groups and interviews to collect qualitative information in the form of participant *narratives*, as suggested by the VC framework (see Table **37**). Specifically, focus groups were conducted with the teams just before the end of semester 2, as we sought to gather current and verified information on learning phenomena as well as capture the team's natural behaviors and interactions during their discussions (Bloor, 2001). Conversely, we aimed at extracting more sensitive information that doesn't normally surface in group discussions, through one-to-one interviews at the end of the semester (Gill et al., 2008).

Driven by the VC framework (see section 2.5.2) the data collection protocol focused on a) primarily, the participants' perceptions of their roles and responsibilities in team-based and CoP-wide contexts, and b) specific VC indicators that could elucidate the value of learning based on its five sub-cycles. Specifically students were prompted to talk about their perceived *importance* of their team-based and community-wide participation (i.e. activities, interactions - Immediate VC). They were also encouraged to talk about their *social relationships* with other CoP members, as well as their personal thoughts and emotions (i.e. self-beliefs, confidence, trust) that surfaced in relation to these. They were then asked to provide insights about how the value of their CoP memberships (i.e. status) and the overall effects this had on their learning (Potential VC). We also inquired about the tools, resources and artifacts used and produced, how they transferred the co-created knowledge into academic work (Applied VC), as well as how students perceived their resulting performances and outcomes (Realized VC). Following from that, we asked them to elaborate on their beliefs on achievement and success in the broader Design domain. Finally, the participants were encouraged to talk about how the overall experience had influenced them as students and as prospective professionals. Instructor observation notes, from the classroom and the interview/focus-group sessions were used as supplementary material.

We also scraped the Facebook (SN) timeline posts generated by CoP members, and obtained the histories for the (one-year) team chats (N=5), as well as the (three-year) group chat (N=1) from students at the end of the academic year, and after the names had been anonymized by a volunteer. The last three were solely used to form quantitative evidence from the aggregate of the exchanges, and inform the Immediate VC analysis (see section 8.4.1).

8.3 Analysis

The transcribed corpus from semi-structured focus group and interview sessions with student participants was formatted and imported into NVivo, a Computer-assisted qualitative data analysis software (CAQDAS). We used a thematic analysis method, split in two coding stages. Specifically, the initial stage of reviewing and coding adopted a structural coding method. This method provides a way to categorize text segments by *topic*, according to the questions asked in the data collection sessions, as a *semantic* (explicit, surface meaning) approach (Braun et al., 2019a; Saldaña, 2015). It is typically used with large, semi-structured data from multiple participants, to get an initial indexing of the text and thus simplify further processing cycles. The initial categories created, reflected topics of learning and concepts from (cross-organizational) CoPs, such as "common goals," "shared repertoire," "co-created knowledge," "perceptions of industry," "perceptions of achievement," then, socio-emotional factors such as "relationships," "trust," "accountability" and "competition," as well as references to technology components like "Social networking," "Facebook chat" and so on. Additionally, segments were coded under the "positive," "neutral" and "negative" tones.

This step was critical for entering the second coding stage, by using the five VC cycles (see section 2.5.2) as priori codes, a process which involved *latent* (deeper, implicit, conceptual) coding judgements. The first overview classification by *topic* (phase 1) helped us become familiar with the data, thus accelerating coding stage 2. For simultaneously coded segments (i.e. coded under a *topic* from the phase 1 and a *VC cycle* from phase 2), this tactic also enabled subsequent comparison queries in NVivo and thus facilitated the analysis of data (Saldaña, 2015). This was clearly a complex process for researchers, as segments of narratives, rarely accounted for one distinct cycle; they shared considerable overlap instead (Booth & Kellogg, 2015). Simultaneous coding within more than one VC cycles was therefore applied in such cases.

Following several comparison and coding rounds, data were categorized under the best-fitting VC cycles as Table 39 shows. Some of these were denser, based on the narratives provided, while others (i.e. *Realized Value* or *Resources/tangible capital*) were informed by quantitative data (i.e. performance scores, number of artifacts produced), to infer the degree of VC. Detailed explanations are offered in each cycle, next.

Table 39: Value Creation (Wenger, Trayner, & De Laat, 2011) coding scheme & resulting references

Value creation cycle			**References**
Cycle 1: **Immediate Value**		Networking/community activities and interactions	247
Cycle 2: **Potential Value**			447
a.	Personal assets (human capital)	Useful skills, new insights and perspectives	185
b.	Relationships & connections (social capital)	Knowledge as a collective good distributed across a community	176
c.	Resources (tangible capital)	Access to resources (documents, tools, procedures, links, visualizations)	18
d.	Collective intangible assets (reputational capital)	Reputation of community, status of profession, collective voice, recognition	3
e.	Transformed learning (learning capital)	Enlightenment in learning, transfer in other contexts	65
Cycle 3: **Applied Value**		Adapting and applying knowledge capital	30
Cycle 4: **Realized Value**		Performance improvement	5
Cycle 5: **Reframed Value**		Redefining success and learning imperatives	144

8.4 Results Based on the Value Creation Framework

The original CoP authors (E. Wenger, 1998) assert that the value of the VC framework lies in its ability to detect particular *indicators* in the *narratives*, that match specific *cycles* of VC. Combining the two - indicators and narratives - helps create a robust picture of the value of learning in a CoP. In this study we provide a detailed analysis of findings investigated through the lens of the five VC cycles. We also include tables at the end of each cycle section, to summarize a) the relevant indicators suggested by the framework b) the specific indicators (positive/negative) extracted from the study and c) the data sources they originate from.

8.4.1 Immediate Value Creation

Immediate VC is naturally entrenched into the CoP activities and interactions (see Table 43). In this study these were observed in members' face-to-face encounters, but most importantly, extracted from the email communication and feedback posts (see Table 40), the SN group timeline (see Table 41) and the group and team chats (see Table 42).

Table 40: Frequency of communication in experimental and control groups

		Faculty members		Alumni mentors			Industrial mentors	
Group	Project	Team emails (threads)	Team emails (unique)	Alumni mentors emails (threads)	Alumni mentors emails (unique)	Behance feedback posts	Client emails (threads)	Client emails (unique)
Exp. (CoP)	1	10	20	3	5	27	8	10
	2	9	23	2	12	21	6	15
	3	9	37	3	13	24	10	24
	4	7	20	2	6	26	1	1
	5	19	47	4	9	27	4	8
	Total:	**54**	**147**	**14**	**45**	**125**	**29**	**58**
Control	1	1	1			n/a		
	2	11	42					
	3	8	16					
	4	5	13					
	Total:	**25**	**72**					

Table 41: Facebook (SN) group timeline results by posts, rating, reaction, shares & comments

	N	**Maximum (per post)**
Posts	205	
Rating	374	73
Reaction	374	12
Shares	0	0
Comments	418	23

Participant descriptions of the rich interactions that occurred (primarily) in the online environments, provided evidence of the immediate VC in its simplest forms, such as information/resource/news sharing, announcements and clarifications, as well as in more structured forms, such as organizing, coordinating, collaborating, reflecting on work, assessing progress and examining work-based situations.

Table 42: Team & group (experimental) chat word counts

Team	Words
A	33,585
B	9,604
C	8,194
D	27,590
E	2,238
Group Chat	69,263

Several student impressions of the SN group were that it served as a forum, filtered only to the topics of interest (i.e. specific coding tasks), versus generic public Q&A sites, like Stack Overflow for example. Additionally, apart from peer help (highly valued in team-chats), members also relied on the instructor's or mentors' help, that were ad-hoc, versus the pre-defined academic meetings and office-hours. Students did not anticipate considerable input from the CoP experts, due to their "probably overly busy schedules."

Despite the lack of full engagement on behalf of the whole community, the SN group was perceived as a resourceful knowledge-base as much for active CoP members, as for mere observers. Specifically, students stated that even *peripheral participation* was essential, as previous threads between others served as examples for resolving their own issues:

> [P1: It doesn't mean that everyone has to participate equally. Some people were indeed more active.. but we were there, watching...]

> [P21: we might have had the same question and we solved it through observing… it was helpful.]

Peripherality was also key in collocated settings, as it allowed for observation of peers' effective team processes:

> [P19: […] other projects, how they had different clients, the way that they had to manage and deal with them […] group-wise you learn more… cause you see others' ways of producing work, faster, better… you learn through this just by observing.]

The narratives also provided evidence of the quality and value of such activities for learners. Primarily, these stemmed from the involvement of industrial experts in the CoP, particularly through their collocated presentations and their ensuing discussions with students (semester 2). A strong indicator of *immediate* value, was found in the talks reflecting on the experts' academic and professional 'trajectories' (triggering a process of *identification* for students*)*, rather than simply marketing their work and current statuses:

> [P14: They didn't come here to brag about their achievements… they talked about their beginnings… It's interesting to hear about it from people who were once in our position, how their lives developed and what they did in order to get here.]

Furthermore, participants were able to distinguish the significance of localized types of knowledge, based on the experts' experience in the local industry, versus more generalized information:

> [P5: I am a registered member in online channels and communities, for guidance on building a portfolio of work and talking with clients [...] but it was beneficial to learn about the local industry, since I can't find that information elsewhere […] and I need to know about it!]

Aside of identification, a strong indicator of the perceived value of participation and engagement was realized in the degree of expression enabled in the CoP, suggesting that students felt at ease (by order of preference) in their team-chats, the group-chat (class-wide) and their face-to-face encounters with external members (i.e. through informal discussions with experts). Additionally, there were reportedly several emotional act-outs, like fun remarks and jokes, as well as tensions and conflicts, that occurred in the group-chat. In fact, amongst other factors, this may have caused the lower student engagement levels in the SN group, since activity was diffused through multiple channels of social communication. While most of such socio-emotional factors fall (conceptually) under cycle 2 (*potential* VC*)*, they are also partially addressed here. They refer to a level of indifference or lack of connection with other CoP members; some were described as "apathetic" and were the "cause of disappointment" for more active others, who felt eager to leverage the role of the practice to improve their learning:

> [P6: I was disappointed, I provided help and others didn't grab the opportunity… it really brought me down […]. Afterall everyone has to contribute!]

Participants also suggested that engagement may have been hindered by the problematic affordances of the SN platform, as the primary tool for community-wide interactions. Most of code-related posts on the timeline were accompanied by screenshots. Students preferred this over pasting the actual code segments, as the timeline lacked code-formatting options. Some students used CodePen (code-snippet testing/showcasing tool) instead, to counteract such issues. However, having to swap between software was found cumbersome and thus affected their active engagement in the SN group altogether.

Table 43: Immediate Value Creation framework indicators themes & data sources

Cycle 1: Immediate Value			
Indicator	Themes		Source
	Positive +	*Negative -*	
Level of participation Level of engagement	Core group participation Peripheral Participation	Low SN group engagement	Self-reported
Level of activity Collaboration	Actual data (see *source* column)	Low SN group activity Technology affordances	SN group Group Chat Team Chats Emails Feedback posts Meetings
Quality of interactions Value of participation Networking Value of connections	Expert trajectories Authentic localized data Emotional expression	Indifference	Self-reported
Reflection	Legitimacy Contribution / social responsibility	Disappointment	

8.4.2 Potential Value Creation (Knowledge capital)

Most of the potential VC indicators (knowledge, relationships, tangible/intangible capital) were linked to the *feedback* from external CoP members (semester 1), and the face-to-face presentations and discussions between students and industrial experts (semester 2). The findings are organized in five sub-cycles next (for a summary see Table 45).

8.4.2.1 Human Capital (Personal Assets)

The systematic feedback on student work, in terms of *volume*, *tone* and *focus* from alumni and industrial mentors, augmented the learning processes and outcomes, as reported in study 3 (see section 6). Students likewise perceived it to have contributed valuable insights that were definitive of their progress. As feedback was extensive, ambiguous and often conflicting, it caused some initial ‘breakdowns’, that urged teams to regroup, reflect on their work, identify appropriate solutions, re-negotiate roles and adopt better learning regulation tactics.

Another influential factor behind the shift in learner knowledge and perspectives, were the regular expert talks in semester 2, that presented their career *trajectories*; specifically, the challenges faced during their transition to the Design industry and their counteractions, triggered a degree of “healthy stress” in students and promoted awareness of the imminent industry endeavors:

> [P1: It was a bit stressful, as it was a long journey to get where he is [industrial expert], but it was beneficial to hear about it.]

Reportedly, students identified with them and demystified these endeavors, by acknowledging “that they (experts) didn’t find things easy either” and therefore, they (students) “should not get disappointed” in achieving the personal and professional development they aspired to:

> [P20: Everybody was kind of lost (experts at the start of their careers)…], [They pushed us – through their talks – to believe in our work […] they told us that they made it in the end…]

8.4.2.2 Social Capital (Relationships and Connections)

Evidence of positive community-wide relationships (students, alumni mentors, industrial experts) was discussed in the previous section (8.4.2.1). We therefore report on the indicators associated with the social relationships regarding the internal (academic) team and group contexts (chats and face-to-face settings). The amount of time spent together and the degree of familiarity amongst peers, contributed towards a positive environment; as it stood, peers shared a *joint enterprise* in that they all aimed for good results, that could be "collectively achieved" (see section 4.2).

Expectedly, negative emotions also surfaced, particularly in two forms of *trust* - *epistemic* and *social*. Epistemic trust related to the degree of academic competence that was commonly acknowledged in the group. Participants explained that a history of subject *know-how* and supportive peer activity, helped establish the perceived competence and credibility of others in the community, since 'history builds trust.' Evidently, the people who had secured a degree of epistemic trust from peers active and assumed some form of leadership. They were also high performers and presented strong accountability towards the community. Nonetheless, the impact of epistemic trust was twofold. While it encouraged some to engage more in the practice, it made less confident others hesitate, making unhealthy self-comparisons and feeling vulnerable in exposing their weaknesses, fearing a hit on their self-esteem:

> [P1: 'A' (an active student) was posting (solutions on technical issues) and I couldn't understand most of them!], [Even if I am 100% sure about something, I won't write it…so that it doesn't backfire on me."]

Interestingly, fear of exposure for these students was not caused by CoP experts, but rather by the prospect of compromising their epistemic status amongst peers. Related to this, came issues of *social trust*, based on the students' social relationships. While they maintained close social bonds and collaborated on technical or generic matters, they did not comfortably share creative work (i.e. design) . They described this as a mitigating tactic for competition: maintaining the 'surprise technique' (only sharing finished versus work in-progress) and not exposing original ideas, could help prevent others from outperforming them instead:

[P2: its different when I'm being asked to help… I will do it then. But I will not reveal my original work and allow others to benefit from my ideas… it will compromise the impact of my own work in the end.]

This approach was observed in a few cases and, as discussed, only concerned creative work, which was still openly shared between smaller clusters, rather than with the entire class.

8.4.2.3 Tangible Capital

We were able to extract multiple design artifacts - as interim and final project deliverables - as well as files, reference lists, links, visualizations and comments, in the shared tools used in the CoP practice. Additionally, the communication frequencies (see Table 25) and the SN group timeline posts (see Table 41) represent CoP-wide generated artifacts. Students repeatedly attributed the importance of these tools, not only in their capacity to generate and store artifacts, but also to act as searchable indexes during practice. An indicative table listing the boards, design artifacts, chats, tasks & comments, files, projects and artwork pieces is presented below (see Table 44).

Table 44: Artifacts and resources in tools: Conceptboard, Google Drive & Behance

	Conceptboard				**Google Drive**	**Behance**		
Team	Boards	Objects	Chat messages	Tasks & Comments	Files	Projects	Artwork	Total
A	3	134	59	17	14	4	14	245
B	2	126	15	7	185	7	16	358
C	1	172	8	28	99	7	49	364
D	3	91	18	9	42	3	12	178
E	3	64	133	4	26	4	14	248

8.4.2.4 Reputational Capital

This sub-cycle refers to intangible assets created in the CoP, such as student acknowledgment of the *reputation* and *status* of the broader professional community, as well as appreciation of their CoP memberships. Specifically, some students presented:

- a high degree of collegiality and intend of contribution, driven by socio-ethical motives:

> [P7: As long as there is interest and willingness to help, we can all move forward (progressing) together.]

- an understanding and respect of the professional status, the authentic project criteria and required level of outcomes from experts in the field:

> [P1: It was inspirational, I would like to be like him (expert), manage big projects and take on serious work!]

> [P13: Competition has increased today (design industry), but so has the need for such people (digital designers)… therefore you have to plan ahead with a focus on exactly what you want to do (in order to succeed)]

- an appreciation of emergent career prospects and reformed future perspectives. Strong work portfolios, sound industry repute and promising professional collaborations were now significant:

> [P2: I want to become a web designer, and these (experts) belong to professional companies… and I have a portfolio to build… for me this was motivating!]

> [P8: I enriched my portfolio with real client work […] I also favor the prospect of this (company) becoming my client.]

8.4.2.5 Learning Capital (Learning Transfer)

Narratives included several indicators of *reformed learning* attitudes. Specifically, students reported that their involvement in practice, enabled them to better identify others' *personality traits* and *skills* and consequently make practical suggestions for learning improvements:

> [P5: I believe this is important (managing CoP communication) especially for some who were in the periphery. They could develop their leadership skills, which are characteristic of project managers […] especially people who are introverts would benefit.]

> [P6: I became better through observation and imitation, why can't this way work for others too?]

The ability to detect competencies and weaknesses in a given field constitutes a crucial transferable outcome, enabling people to make effective partnership judgements, a much-needed skill in both academic and professional contexts.

Furthermore, several students emphasized the importance of effective planning and management, reflecting on their project initiation phases, which evidently felt 'quite uncertain'. Conversely, post-intervention narratives indicated increased confidence and significant improvements in terms of learning management:

> [P18: It's not a matter of who knows what best, if you invest time you will learn anyway, but it all comes down to planning: let's put everything in order, finish one task, then start with the next one … don't work randomly, we cannot do that anymore...]

Lastly, reframed beliefs about *identity* in learning surfaced, both as an individual and a collective experience:

> [P5: I learned that I had to have self-knowledge […] there was definitely an effect on me, a beneficial one. You learn to collaborate with people who are different (referring to industrial CoP members), to hear and respect their opinion and make an effort not to progress alone, but help others too (referring to student CoP members), so they learn from you and therefore everybody moves forward together.]

Table 45: Potential Value Creation framework indicators (Wenger, Trayner, & De Laat, 2011), themes & data sources

Cycle 2: Potential Value			
Indicator	Themes		Data Source
	Positive +	*Negative -*	
Human capital Skills Acquired Information received Change in perspective Inspiration Confidence	Trajectories Changes in perspective: encouragement, motivation, confidence	Stress	Self-reported

Social capital Types and intensity of social relationships	Familiarity Trust: epistemic Leadership Competition	Individuality Distrust: social Fear of exposure	
Tangible capital	URLS, resources, artifacts		
Reputational capital	Live projects, clients, mentors Status of profession Career prospects		Actual
Learning capital	Metacognition, co-regulation Intra/inter-personal skills Collaboration		Self-reported

8.4.3 Applied Value Creation

Applied value creation refers to the transfer and integration of knowledge that was co-created in practice, back into the practice. This transfer surfaced in several narratives (see Table 46). Specifically, aside of general *intra* or *inter-team* transfer, the most significant learning transfer was instigated by feedback, as a crucial factor of community-wide collaboration. While its effects on learner perceptions and outcomes are extensively analyzed in study 3 (see section 6), some prominent mentions are presented here too:

> [P15: It (feedback) helped us, we did the prototypes and we were stuck […] working on them again and again, non-stop […] they (alumni mentors) gave us a clear perspective (of our work), seen from a different lens.]

The feedback was not only an outcome, but also a *stimulus* for work outcomes, as it urged students to make *proactive* adjustments prior to submitting their work, based on self-forecasts of possible comments:

> [P19: I knew they would mention the buttons. I knew they were problematic, so I wouldn't post it (the prototype) […] we worked further on it instead) […] so that we would get better feedback eventually.]

At the same time, the extensive and challenging forms of feedback, caused frequent confusion and delays. As mentioned, students tried to counteract these through better regulation strategies; thus, both proactive and reactive responses to feedback, led to improved regulation and better outcomes, which denotes an effective degree of *Applied* VC.

Finally, students verified the importance of the theoretical principles learned in class, as they *concurrently* encountered them in CoP practice. Evidently, having the opportunity to put theory into practice, while working on industry projects, submitting deliverables to and following the guidance from mentors and clients at the same time, confirmed the value of theory and offered learners a holistic understanding of the subject:

> [P19: UX design: I realized the whole meaning of this field, its branches and what paths we can follow as learners, I realized how diverse it is […] It was when we were working on the time-plan (Gantt chart), and I was responsible for it (i.e. providing the client with the time-plan) in the project)].

Table 46: Applied Value Creation framework indicators (Wenger, Trayner, & De Laat, 2011), themes & data sources

Cycle 3: Applied Value			
Indicator	Themes		Data Source
	Positive +	*Negative -*	
Implementation of advice/solutions/insights Use of tools and documents to inform Practice Innovation in practice Innovation in systems	Feedback transfer: proactive / reactive Reformed co-regulation	Confusion Frustration	Self-reported
Transferring learning practices	Concurrency in theory & CoP practice (application)		

8.4.4 Realized Value Creation

Realized VC refers to the *improvements in performance* as a result of CoP participation (see Table 47). In this case, indicators of realized value were discernible in the epistemic outcomes of students, such as the final exam scores and the evaluation ratings of the websites produced. Firstly, statistically significant differences ($t(35)=-2.33$;

p=.025) were detected in the comparison between the experimental (M=66.95, SD =13.04) and control groups' (M=55.71, SD=3.92) exam scores (see Table 24) with a large effect size (d > 1.167; see Cohen, 1988). Additionally, the websites developed by the experimental teams were evaluated (M=4.17, SD=1.34) with significantly higher scores (see Table 23) to those of the control teams (M=3.23, SD =1.64). Participation in the cross-organizational CoP thus resulted in higher epistemic and creative outcomes, a full analysis of which is presented in study 4 (see section 5).

Table 47: Realized Value Creation framework indicators (Wenger, Trayner, & De Laat, 2011), themes & data sources

Cycle 4: Realized Value			
Indicator	Themes		Data Source
	Positive +	*Negative -*	
Personal performance Organizational performance Organizational reputation	Knowledge gains Creative achievements		Actual
Knowledge products as performance	Delivery of knowledge products: user manuals and training	Frustration	Actual Self-reported

8.4.5 Reframed Value Creation

This cycle comprises indicators of *reframed success*, *learning* and *practice* imperatives, ensuing from CoP membership (see Table 48). Firstly, reformed achievement criteria were expressed by the entire group. The need for a 'sound academic performance' was now replaced by the desire to fulfill broader expectations that emerged through practice. In fact, the advent of experts, their talks and demonstrations of professional work, highlighted the students' perceived humble statuses and affected their self-concept, to some degree:

> [P11: we wanted to investigate… to find solutions for client requirements […]. We had high expectations, that were not met […] we were disappointed by the functionality we could not achieve.]

> [P20: He (expert) has achieved so much… and my portfolio only has two small projects in it.]

This is not necessarily a bad outcome. The transformed perceptions of *achievement* renegotiated the students' objectives, from purely academic (grades-driven), to more professional and community-driven. They were evidently now better able to understand "what the industry and potential employers were looking for," so they could gear their efforts towards more meaningful directions. This urged them to reconsider their *identities*, both in terms of the skills they had or hadn't already developed, and hence realize where "they currently were" and where they were "headed to." To accomplish desired outcomes, new sets of reformed rules, imperatives and trajectories emerged for many:

> [P4: He developed sample webpages on his own to build his portfolio. We will also follow his example this summer.]
>
> [P13: They (experts) didn't worry about their weaknesses, they encountered them and built on them as they went along, they became more competent and thus developed their careers in this way.]

Table 48: Reframed Value Creation framework key indicators (Wenger, Trayner, & De Laat, 2011), themes & data sources

Cycle 5: Reframed Value			
Indicator	Themes		Data Source
	Positive +	*Negative -*	
Community aspirations	Understanding of global community needs		Self-reported
Assessment	New metrics Reformed criteria of achievement	Stress, self-concept	
Relationships with stakeholders	Admiration, adaptation		
Institutional changes New frameworks	Specific pointers & directions		

8.5 Discussion

In this work we set out to understand and analyze the *value of learning* that was facilitated through participation in a cross-organizational CoP, by reporting on categorized findings based on the VC Framework (**RQ5a**). Next we review these VC findings (as five different themes) from the perspective of *identity* (**RQ5b**), and the conceptualizations related to it, according to foundational CoP theory (see section 2.3.5). The themes extracted from the analysis refer to a) the participation and *engagement* patterns through the CoP members' activities and interactions (Immediate VC), b) the valuable insights from the practice, leading to the steering of *imagination* (Potential VC), c) the effects of the CoP on the members' practice and especially the importance of *brokering* (Applied VC), d) the effects of the CoP on members' performances, particularly through their *boundary* experiences (Realized VC), and e) the shift in learner perspectives and *alignment* with the broader (professional) community (Reframed VC).

8.5.1 Activities and Interactions: Participation & Engagement (Immediate VC)

The sum of activities and interactions were inherent in the face-to-face and online collaboration sessions, the frequent one-to-one interactions, communication threads, feedback posts and overall SN community-wide exchanges. Below we examine these with a focus on *engagement*, that is the immediate active involvement in the community, as well as participation, that is the overall CoP membership that perpetuates with or without engagement. Both are inherently linked to identity according to CoP theory.

In one aspect, the immediate nature of CoP activities implies engagement, as a *mode of belonging* in the practice. Although it fluctuated across time, it still constituted an important source of learning for the majority of participants (the assertion is reasoned in the next sections). The enabling factors for both participation and engagement, were a sense of connectedness, the degree of familiarity between learners, the development of epistemic trust and the gratification of contribution - as a social responsibility - mostly amongst classmates. On a community-wide level, participants saw the immediate value of their participation mainly in their exchanges with CoP experts (alumni, industrial mentors and experts). Conversely, the factors impeding engagement in practice concerned competition, distrust (intra and inter-personal) and - on behalf of some - lack of interest or identification with the community.

These findings verify two key concepts linked to identity through the CoP lens: a) the complementary nature of the individual and collective identities and b) the learning benefits of both *participation* and *non-participation* in the CoP.

Firstly, the existence of both positive and negative expressions concerning engagement and participation, ascertains the balance of the individual and the collective experiences of identity. It is unrealistic to assume that learning in CoPs is only of value, if it evolves without issues. Aligning with CoP theory (E. Wenger, 1998), our analysis extracted that for each sign of individuality (distrust, competition), a sense of collegiality (trust, familiarity, sense of accountability) emerged. For each conflict, tension or disagreement, came an act of loyalty and contribution (information-sharing, support, leadership, generosity). Thus, these participation and engagement phenomena – whether harmonious or conflictual – occurred, still enabled the negotiation of meaning and helped co-create knowledge and competence, hence transforming learner identities accordingly.

Secondly, both *peripherality* and *non-participation* were constitutive of learning and identity (re)formation. In the cases of moderate participation, on behalf of a few (i.e. in the SN case), gathering 'glimpses' of information and drawing meanings, still contributed to learning of value (E. Wenger et al., 2002a). Peripherality may have happened due to difficulty to understand the level of knowledge that was being co-created, and/or making unhealthy self-comparisons in result. Nonetheless, peripherality also clarified people's position and level in the CoP, revealing the direction to full participation towards the 'optimum' (i.e. high levels of competence) and the means to get there (*potential*). The beneficial role of *peripherality,* as a form of 'inactive' awareness and interest in the practice, in the progressive development of confidence was also prominent in the study (*immediate*, *applied value*), as peripheral members were given the space to gradually feel safe and build enough self-trust to engage more actively in the practice.

In other cases, *peripherality* and *non-participation* were attributed to the lack of interest and identification with the subject (WDD) of the practice. Even so, this type of students still acknowledged the value of the practice, particularly through the encounters with experts who motivated them to "consider their options" and "feel better prepared" for their industry transition (*potential, reframed*). Even in the absence of full participation, the practice still mediated critical information about the global community (industry practices, status, methods, criteria), even for those who didn't fully identify with it. Hence lack of or peripheral participation still played an important part in the transformation of learner identities in the CoP.

8.5.2 Valuable Insights and Imagination (Potential VC)

An instrumental factor of *potential* and *reframed value creation* in learning, was the exposure of learners to expert paradigmatic trajectories (alumni & expert mentors), as the "lived models" (E. Wenger, 1998) of the practice. One step before the onset of their career, learners appreciated the legitimate access to this information, admitting that it surpassed other forms of learning. By highlighting the trajectories - rather than merely publicizing accomplishments - the expert stories stimulated cycles of *identification* and *negotiability* for learners (E. Wenger, 1998).

Firstly through identification, they became invested in their relationships with experts; they were inspired, motivated, and also cautioned about the realistic challenges lying ahead (Woods et al., 2016). The communication of both encouraging and unfavorable 'truths', as well as the precise and localized guidance, made the majority of participants feel more confident, in terms of vocational awareness and the status of their intended profession. It also 'grounded' them, urging them to move outside their comfort zones, initiating a process of *alignment* with the global community (E. Wenger, 1998). Through the new meaning negotiations that transpired through the encounters with experts, they reflected on their past, and reformed their future trajectories "towards membership in the professional community of practice" (Morton, 2012).

Anchored in their new industry connections and their improved self-trust (following the implementation of real-life projects), career development and partnership prospects were clarified and became plausible. Whether they would – or not - be realized, these aspirations were acts of *imagination*, in progressing from a local to a 'global' projected reality "that becomes constitutive of the self" (E. Wenger, 1998) and transforming, in this way, the identity.

Finally, a key aspect of *potential learning value* in the study, was the transfer of boundary objects (see section 2.3.6). These refer to a) the artifacts produced in practice (i.e. briefs, reports, time-schedules, Gannt charts, sitemaps, low/high-fidelity prototypes) and b) the dissimilar member exchanges, in the form of posts, chats and other communication elements, as boundary objects that traversed practices to reach a diverse audience (students, alumni, expert and industrial mentors). Technology was critical in allowing these objects to be mediated across boundaries. It thus supported more unified forms of *participation* and *reification* in the practice through objects that carried rich and diverse information with them.

8.5.3 Influence on Practice and Brokering (Applied VC)

Amongst other factors, the systematic and rigorous feedback on a community-wide level, was constitutive of the *applied learning value* that was generated by the CoP. It highlighted the importance of the interactions between local and global forms of identity in practice. In this regard, identity was not entirely local, since it didn't solely focus on academic objectives, but also embedded understandings and aspirations of fitting into the broader community across a *landscape of practice* (E. Wenger, 1998, 2013).

It was evident that, although challenging, the feedback mediated insights, judgements, methods, criteria, directions and expectations, that were key in other communities or constellations of communities (global) into the local practice – what is defined by theory as *brokering* (see section 2.3.6). As the experts had established a satisfactory level of legitimacy in the CoP, they influenced the teams' practice through their feedback, which had to be integrated into the work either *proactively* or *reactively*. This required efforts for translation, coordination and alignment in comprehending and reacting upon it. The initial team tensions and breakdowns that feedback caused, "fertilized" (Marcandella & Guèye, 2018) a series of creative *co-regulation* counteractions and led to greater epistemic achievements in the end, as these were made evident in the *realized VC cycle* analysis.

Thus, feedback, as a strong form of brokering in the cross-organizational CoP enabled learning in ways that might not have otherwise materialized in traditional HE or intra-organizational CoPs. This expanded the learner identities significantly through an interplay of local and global perspectives, that had to be understood and managed to achieve alignment with the broader community.

8.5.4 Effects on Performance and Boundary Experiences (Realized VC)

The emergent social relationships in the CoP and the strive for outcomes of quality that would be valued by experts, generated increased commitment and creative effort in learning. This became evident in the student outcomes, in subject-level knowledge (exams) and website evaluations, to be exact. Further, the swapping of roles from learner to educator, to train less-knowledgeable stakeholders (clients), so as to establish good communication and deliver knowledge (i.e. user-manual and training), confirms the renegotiation of learner perspectives. Understanding the broader practice and opening a window for others into the local practice, yielded a shift in learner identities, in order to manage this “rich and complex set of relations” (E. Wenger, 1998), as a series of *boundary* experiences in the CoP. As these lessen the distance between identity in education (local) and identity in its pre-professional and professional states (global), they therefore indicate a strong degree of *realized* VC (Jackson, 2016).

8.5.5 Shift in Perspectives and Alignment (Reframed VC)

This study set out, with a main goal to inform about and orient novices towards the broader context of their practice (global), by inviting external members to mediate the industry into the curriculum. As verified by narratives in all VC cycles, it has effectively realized this goal. Through the maturation of practice, a lot of the energy in the *local* engagement shifted toward the broader community (*global*). The expert insights steered acts of *imagination*, by expanding students’ understanding of the practice, cultivating their aspirations and highlighting their professional potential.

Resulting from these, the assessment criteria and the concepts of *achievement* and *success* were also transformed to match those of the global community. This was largely attributed to their influential exchanges with alumni and expert mentors, as well as their boundary experiences with industrial mentors (clients), through their collaboration in authentic projects.

Whether these carried a positive (exemplification, motivation) or negative (stress, affected self-concept) valance, they still indicate a high level of *reframed* VC, since new understandings and imperatives for learning and practice emerged in both cases. They involved inter-personal collaboration skills (i.e. detecting own and others’ traits, developing people-skills, co-regulating processes), and vocational preparedness (i.e. adopting expert development tactics for work-portfolios, safe-costing, career-seeking and alignment with industry criteria) as efforts of *alignment* (E. Wenger, 1998). Alignment requires learners to autonomously set new work strategies, to coordinate their energy and actions in gradually becoming members of the global (professional) community. These significant indicators of *reframed* VC, strongly confirm the restructuring of learner *pre-professional identities*, through the sum of experiences collected in their CoP memberships (Jackson, 2016).

In effect, this research confirms the realization of the three *modes of belonging* grounded in the principal CoP theory, that are constitutive of *identity* transformation through CoP practice. These reflect modes of *engagement*, *imagination*, and *alignment*, that were cultivated in practice through exposure of learners to paradigmatic trajectories, the transcendence of objects across the two spheres, and the valuable boundary experiences that were enabled through the CoP (see Table 49).

Table 49: Emerging themes of Value Creation cycles and effects on learner identities

Cycle 1 Immediate Value Activities, interactions, participation & *engagement*	**Cycle 2 Potential Value** Valuable Insights & *imagination*	**Cycle 3 Applied Value** Influence on practice & *brokering*	**Cycle 4 Realised Value** Effects on performance & *boundary experiences*	**Cycle 5 Reframed Value** Shift in perspectives & *alignment*
Core & peripheral participation	Expert trajectories	Feedback transfer: proactive, reactive	Knowledge-gains	Understanding the global community needs
Actual data (posts, communication, feedback)	Encouragement, motivation, confidence	Reformed co-regulation	Creative achievement	New metrics Reformed criteria of achievement
Expert trajectories	Trust (epistemic, social)	Concurrency in academic & CoP practice	Delivery of knowledge products: training & user-manuals	Admiration, adaptation
Authentic localized data	Leadership			Specific pointers & directions
Emotional expression	Competition			
Legitimacy	Resources, artifacts			
Contribution, social responsibility	Live projects, clients, mentors			
	Status of profession			
	Career prospects			
	Metacognition co-regulation			
	Intra/inter-personal skills, collaboration			

8.6 Summary

This chapter presented the fifth study falling under phase **2** - *Evaluation* – and assessed the *value of learning* and the effects on the learners' *identities*, as the result of their participation in the technology-supported, cross-organizational CoP in the context of HE Design studies.

Using the Value Creation framework, findings have been classified and analyzed within the scope of its five distinct cycles. The satisfactory levels of VC in all cycles denote the effectiveness of the cross-organizational model, applied in this and relevant research contexts. Further, the exploration of VC-based findings from a CoP-oriented identity perspective, indicates that the evolution of the three *modes of belonging* – as constitutive dimensions of identity – evidenced in this analysis, confirms the beneficial shift of learner identities toward their pre-professional status.

In deriving these outcomes, this study corroborates the importance of the critical interlocking of the technological, epistemic and social designs, that constitute an appropriate ecology for the complex practices of CoPs in the Design and adjacent educational fields. This lays the groundwork for producing a design guidelines model to benefit researchers, educators, and designers who wish to leverage the potential of bridging the academic and industrial spheres, to improve learning in the field of Design studies and related domains.

9 Phase 3 - Cross-Organizational CoP Governance: Design Implications

Study **6** in Phase **3** – *Integration* - draws from the sum of all previous study findings that comprise this research. It specifically identifies the effective and the challenging (or limiting) findings, extracted from the enactment of the cross-organizational CoP model, and integrates these into a structured set of practical *design guidelines*. This can assist researchers and practitioners, as CoP stewards, who wish to adopt the cross-organizational approach to design, enhance or evaluate other learning environments. We use the term “steward”, offered by Wenger et al. (2009) in the VCoP framework, to refer to the role of CoP administrators, who may be educators, researchers, designers, or other practitioners.

This study reflects an overarching research aim which responds to the call for *governance mechanisms* that target specific types of CoPs (cross-organizational), integrated within particular epistemic fields in education (Design and adjacent disciplines), and have specific purposes (i.e. soft skills development, creative outcomes, vocational relevance, pre-professional identity formation) (see section 2.7.1.1).

This chapter outlines the different guidelines that were extracted based on the empirical findings of the five studies that comprise the first two phases of this work.

9.1 Introduction

Building on the outcomes of the first two phases of this work, this study provides a collection of actionable *design guidelines*, that are grouped under various thematic categories (see Figure 30). These fall under each one of the ACAD (analytical framework) (see section 2.5.1) components, namely the *Set* (technological setting), the *Social* and the *Epistemic* components. We notify the reader that the *themes* and respective *guidelines* may often appear to match the scope of a different component. This is anticipated, as these components are entangled and share considerable overlap. According to related theory, they are more easily discerned on a conceptual, rather than a practical or analytical level (P. Goodyear & Carvalho, 2016). In acknowledging this challenge, we attempt to classify the themes and guidelines as accurately as possible, under the component (set, social, epistemic) they most strongly associate with.

The themes and guidelines are enriched with relevant information from all studies to aid understanding and to help the reader gain contextual relevance. As mentioned, these point to either effective or problematic dimensions of the CoP model's enactment that warrant attention from CoP stewards in their governance efforts. It should be noted that although this research focuses on the learners' perspective, this stage (integration) also includes some views and suggestions from external CoP members (alumni, industrial mentors, and experts) that have surfaced during informal discussions following the intervention.

This phase is therefore guided by the following overarching question:

RQ6: What are the design implications for a learning ecology that can effectively integrate a cross-organizational CoP in the HE Design studies?

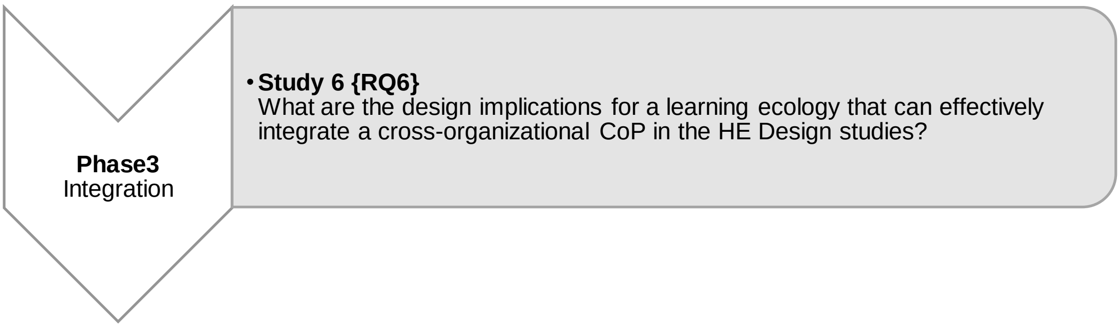


Figure 30: Study 6 overarching research question

9.2 Design Implications

Table 50: Design implications extracted from the findings of phases 1 and 2 of the study

1	**SET**
SE1	Integrate member-preferred social networks (SN), field-specific creativity-support tools (CSTs), generic productivity, and online showcasing tools in the CoP technology configuration
	Technical & Design-oriented communication: practical and socio-emotional considerations
SE2	Integrate effective technical Q&A interface capabilities, like code-snippet sharing, execution, and debugging, within the social CoP platform
SE3	Integrate automatic or manual gamification features in the social CoP platform to promote student interest and engagement in the practice
SE4	Guide learners to make use of appropriate language for effective technical communication
SE5	Support modular visibility to accommodate various ad-hoc CoP interactions, both from the initiator & the target member perspectives:
	SE5.1 Provide on-demand activity-driven permissions
	SE5.2 Provide on-demand role-specific permissions
	Visual design-oriented interactions
SE6	Aim to enhance workspace awareness in terms of peers' identity, position & activity in visual CST workspaces
SE7	Integrate various channels for multimodal communication in visual CST workspaces
	Interoperability
SE8	Enable interoperability between CSTs, generic productivity, SNs, and other tools included in the CoP's technology configuration
2	**SOCIAL**
	Power relations: trust, competition & accountability
SO1	Aim for even distribution of power through the balance of trust, competition & accountability in the CoP
SO2	Empower external CoP members with compound and in-depth information on their purpose and role, as well as the other members in the practice
	Interpersonal (peer trust)
SO3	Schedule regular work crits with students for constructive peer review, commencing early on in the project cycle
SO4	Assign different industry projects and clients to different CoP teams, ensuring that they require same-level subject knowledge, creative adeptness & technical competence
	Intrapersonal trust (self-efficacy)
SO5	Aim for mixed-competence teams to form the CoP's working subgroups
SO6	Aim for community-wide face-to-face interaction early on and throughout the life of the CoP in order to boost online participation
	Accountability
SO7	Limit the size of the CoP to enhance member accountability
SO8	Highlight the incentives, purpose & responsibilities of each CoP role at the start & regularly throughout the life of the CoP
3	**EPISTEMIC**
	Time
EP1	Invite community-wide participation in the design of the learning ecology prior to its enactment
EP2	Introduce visual representations to simplify the epistemic design and clarify its practical implications early on in the life of the CoP
EP3	Allow for sufficient time to pilot-test the epistemic design prior to the commencement of critical CoP-based learning practices

EP4	Plan the academic curriculum to coincide – thematically and temporally - with CoP-based activities
	Feedback
EP5	Aim for regular feedback and evaluation of student work from expert CoP members to enrich the academic feedback process
EP6	Proactively negotiate the focus, amount and tone of feedback with external CoP members
EP7	Articulate comments appropriately to encourage reciprocal feedback activity in CoP-wide settings
	The purpose of expert CoP members
EP8	Invite industry members with various degrees of expertise to provide briefs, expert insights, feedback and evaluation for student work
EP9	Recruit recent graduates for the role of alumni mentors in the CoP
EP10	Aim for sharing expert trajectories and 'inside' information about the industrial practice
EP11	Always include real industry clients & authentic projects to guide the CoP-based activities

9.3 Set Design Implications

Below we outline some key findings in this research with regard to the CoP's *technology configuration* which is informed by relevant findings from the technology-adoption evidence (see section 4.5.1). We initiate this section with a generic guideline, whose parameters are described in full detail in study **1** (see chapter 4), which suggests that CoP stewards should aim to:

> ***SE1.*** *Integrate member-preferred social networks (SN), field-specific creativity support tools (CSTs), generic productivity, and online showcasing tools in the CoP technology configuration*

As an example, in this study the above guideline was implemented by employing: a) Facebook group, as a social networking (SN) tool, b) Adobe Suite, ConceptBoard, and Axure RP as field-specific creativity-support tools (CSTs) c) Google Drive, Google Docs, email clients, chat and video-conferencing for generic productivity purposes, d) Adobe Behance and Hypothes.is as online showcasing and feedback tools and e) learning management systems (Moodle) (see Table 17). The last category (and any other also) can be omitted if the instructional requirements are fulfilled by the aforementioned tools.

Next, we proceed with targeted guidelines on specific aspects of the technology configuration. As discussed these apply to the primary CoP activities in Design-oriented disciplines (i.e. technology, engineering, HCI) that rely heavily on online *technical* and *visual* design communication in online tools during collaborative learning and work (L. Dym et al., 2005).

9.3.1 Technical and Design-oriented communication: Practical and Socio-emotional Considerations

9.3.1.1 Practical Considerations

As it stands, technical communication in online spaces relies on certain interface features that facilitate the sharing and reviewing of (programming) code. In addition to findings from the study, we also extracted key points from related research (i.e. technical ‘question and answer’ (Q&A) sites) to support the implications that follow.

Since this study dealt with an organic, pre-existing CoP, its configuration’s primary aim was to employ similar tools to those used by its members up to that time, such as a SN for instance (as described in *SE1*). While this decision was suitable in this case, it also appeared to somewhat stretch the technical communication of learners since the SN interface offered little support for reviewing and debugging code; a fact that led to lower SN participation in return.

Initially, the code (informational data) was poorly comprehensible, as there was no interface-supported option to ‘format as code’ and thus, to differentiate it from natural language (conversational data). Amongst others, this is a typical feature of technical Q&A sites like ‘Stack Overflow’, who allow users to type or paste *code snippets* that can be suitably formatted, edited and also ‘run’ (executed) directly in the platform (Mamykina et al., 2011; S.-H. Yang, 2016). To assist with coding issues, collaborators need live-editing and debugging capabilities. In the study, students worked around this by copying and pasting code snippets (or typing from scratch) in external editors (i.e. desktop or online IDEs) to reproduce the coding issue. Aside of being time-consuming, this also discouraged SN participation. Community stewards could therefore proactively incorporate such functionality (using relevant APIs) into their CoP’s main platform, or employ dedicated tools that:

> ***SE2.*** *Integrate effective technical Q&A interface capabilities, like code snippet sharing, execution and debugging within a social CoP platform*

Further to this, student suggested features like that ability to *tag* (meta descriptions of the topic) a post, to help build a searchable index of posts; or a *voting* system (i.e. based on the answer's correctness) in the SN, to generate *scores* and earn *badges*, and thus help elevate student interest. While these can be integrated and monitored manually (i.e. by the CoP steward), they are most beneficial when they are natively supported in the system, like supporting eh automatic aggregation of information for evaluation for instance (the latter necessitates les effort from the CoP steward). Finally, as suggested by participants, statistics on question/post popularity (either *viewed*, *read*, or *answered*) may offer useful insights about the meaning-making processes in the practice. Hence the next guideline:

> ***SE3.*** *Integrate automatic or manual gamification elements in the social CoP platform to promote student interest and engagement in the practice*

It is also equally important that participants are encouraged to use simple language, and follow some ground rules for technical and natural text communication; for instance, *what* and *what doesn't'* constitute clear and factual information, complete and all-rounded answers, and team-based or community-wide communication, as per the following guideline:

> ***SE4.*** *Guide learners to make use of appropriate language for effective technical communication*

Class-based PBL methods can be employed for training novices. For example, following short presentations on the key principles of *technical* communication, student teams can be encouraged to practice their technical writing and presentation arguments, for delivering class-wide peer reviews, based on suitability, conciseness, and communicational aptitude. While this is key for issues of technical nature, it can also be beneficial for students' generic (online/offline) communication skills.

9.3.1.2 Socio-Emotional Considerations

Issues of affective nature, primarily deriving from insufficient technical communication, were also extracted in this research. Specifically, the fact that the different projects of student teams had varied requirements, generated, at times, SN posts of dissimilar (technical) nature. This scenario urged a few of the participants to resort to *private team chats* instead, as these focused on relevant issues of immediate interest only. Chats were also perceived as ‘safer’, by filtering out what was ‘unnecessary and stressful’ information. Through chats, students weren’t prone to make ‘unhealthy’ comparisons between their own and others’ more advanced technical work (in the SN), that evidently ‘made them feel nervous’.

The CoP’s main platform’s interface (SN or other), can help moderate such socio-emotional issues that may act at the expense of learning, especially in the case of ‘underpowered’ learners. This calls for a *modular visibility* approach, to support more targeted interactions (i.e. one-to-one, one-to-team, team-to-team etc), whenever these are needed in practice. The following implication is of a broad nature, because it encompasses two sub-guidelines that target the areas of a) *activity,* and b) *role permissions* (see Table 51). The guideline is also equally appropriate for *technical*, *design* and *generic* communication issues in virtual CoPs. As such, CoP stewards should aim to enable the practice with systems that:

> ***SE5.*** *Support modular visibility levels to accommodate various ad-hoc CoP interactions, from both the initiating and the target member perspectives*

Firstly, any platform or tool used to support the CoP practice, should allow *selective initiator visibility,* that refers to the person who initiates a question, post, task, artifact creation and so on. For example, members should be able to initiate an activity by choosing to go by their *name,* their *team’s name,* or as *anonymous* (amongst the class group or CoP) users (see Table 51). This addresses concerns of exposing *personal* weaknesses and vulnerabilities, by promoting a sense of safety if needed.

Secondly, it should afford selective *target member visibility*, that is, making a post visible to specific CoP members only. An example would be that of a student posting a question and selecting a group of members, that may consist of a specific *peer,* an *alumni mentor,* and the *instructor* of the module. In this way, communication can be fluid, adaptive and fine-tuned to the specific needs of the initiator or the targeted clusters of people, who are more *relationally proximal,* or more likely to reciprocate. This can help boost the overall flow of participation in the practice, even if it transpires in separate parallel channels. We also expand the topic of *visibility*, to include more detailed parameters, such as *activity and role* permissions below.

This work has identified distinct development phases in the Design cycle, which are associated with different types of user behavior and interaction, especially in CSTs (vector-editors, virtual shared canvases etc.). For example, the more artistic design phases are perceived as largely individualistic. Synchronous co-editing during these phases may therefore not be preferred. That said, less intrusive and moderate input (i.e. suggestions and corrective comments) from peers, may be desirable for preventing oversights or incorrect decision-making. This calls for platforms and tools that provide authors (initiators) with the choice of different permissions on specific *activities*. Specifically the interface should:

SE5.1. *Provide on-demand activity-driven permissions*

Permissions for the target users (i.e. collaborators) could include the basic *edit*, *view*, *review*, and *collaborate* modes that could either be assigned to a specific workspace (i.e. canvas#3), or a particular artifact (i.e. a webpage menu) for example (see Table 51). Permissions could then bind to an index of *user roles*, to provide more precise personalized access, as described in the following guideline:

SE5.2. *Provide on-demand role-specific permissions*

This stems from the reported intrusion (overwrite, duplication, deletion) issues in CSTs. In this work, participants demanded different levels of *target* visibility, i.e. team-only or community-wide visibility in different phases and situations. To achieve this, additional software tools were used. For instance, a specific tool was used to host *work* that was *in-progress* for *team-only* visibility, and another tool for *showcasing* completed work that required community-wide visibility. This back and forth tool-switching demanded additional time and effort from the teams. In line with ***SE5.1*** and ***SE5.2***, we suggest that the online CoP platform (i.e. a CSTs), should provide a combined matrix of *initiator visibility*, *target activity* and *role permissions*, that reflects the CoP's social structure and the individual preferences of users at any given time. This can help aggregate a fully fluid, multi-visibility, multi-activity and multi-role matrix as Table 51 demonstrates:

Table 51: Proposed modular visibility scheme: initiator and target visibility, activity and role permissions matrix

Initiator visibility	**Target visibility**	
Visibility settings	**Activity permissions** *Workspace* OR *Artifact* level	**Role permissions** *Workspace* OR *Artifact* level

☐ Member name
☐ Team
☐ Class / group (anonymous)
☐ CoP (anonymous)
	☐ Edit
	☐ View
	☐ Review (Q&A)
	☐ Collaborate
	    ☐ Chat
	    ☐ Stickies
	    ☐ Voice Call
	    ☐ Video Conference
	    ☐ Screen Share
	    ☐ Point
	☐ None
		☐ Admin
		☐ Team
		    ☐ Team Leader
		    ☐ Member 1 (name)
		    ☐ Member 2 (name)
		☐ Group (class)
		    ☐ Student 1 (name)
		    ☐ Student 2 (name)
		    ☐ Student 3 (name)….
		☐ Community
		    ☐ Alumni Mentor
		    ☐ Industrial Expert
		    ☐ Industrial Mentor (client)
		☐ Public

To help clarify this scheme, we offer a possible scenario whereby an author (initiator visibility) of an *artifact*, has the flexibility to label it by their name or choose to remain anonymous. For *target visibility*, they can choose to assign a *review* permission for all Alumni mentors, an *edit*, *chat* and *voice-call* permission for Team Members 1 and 2, and a *view* permission for class-wide access for example. Likewise, a team leader can also configure target permissions for a large *workspace* area, such as the entire team *canvas* in a CST for example.

This provides the ability to change visibility permissions depending on the particular needs of the CoP practice at any given time (co-configuration). Tools should accommodate these alterations, just as it happens in face-to-face situations; people can fluidly choose who to meet, work with, present work to or seek help from on different occasions. In this way, the environment can serve as an authentic ad-hoc, peer-to-peer, team-based, group-wide (class), community-wide or public space for specific activities, eliminating in this way the need to use additional platforms and tools to do so.

9.3.1.3 Visual Design Interactions

The following two guidelines focus on *visual* design interactions (i.e. drawings, diagrams, 2D/3Ddesign artifacts) that are important for CoPs in the Design disciplines.

It mainly concerns collaboration in synchronous CSTs (i.e. Conceptboard) and it addresses the lack of suitable application affordances to enable *workspace awareness*. This refers to the users' awareness and perception of their environment with regard to the presence and activities of others within that (Gutwin et al., 1996).

Various concerns of this nature were extracted in this work. Specifically, one of the causes for *duplicate*, *overwrite* and *deletion* of artifacts in shared CSTs, were due to insufficient real-time visual indicators of others' activities in them (Forghani et al., 2014). This generated outcomes such as mistrust, increased sense of ownership, individualistic behavior or lack of accountability in teams. To avoid such phenomena, collaborators should be able to feel and behave as truly 'immersed', while at the same time, have a clear idea of what goes on in the shared space (Cherry & Latulipe, 2014). CSTs should therefore:

> ***SE6.*** *Aim to enhance visual workspace awareness in terms of peers' identity, position and activity in visual CST workspaces*

The interface should facilitate natural *workspace awareness* without added overhead; that is, without the need to shift visual attention between panels and sidebars to look for peer activity. Instead, these should be intuitively 'detected', what is also known as "lightweight information gathering" (Gutwin et al., 1996). Simple means of awareness enhancement can be employed. For instance, suggestions made by the participants in our studies involved the manual indication of *runtime* activities, through *color-coding* (background, framed, or highlighted areas), and labelling the artifact's owner by name, indicating a *state of edit* (user-defined). Alternatively, a natively-supported feature can indicate user activity via real-time cursor movements (i.e. an existing Conceptboard feature). In addition, artifacts in those areas could be labelled to signify their state, such as "*completed"*, or *"in-progress*", to prevent concurrent changes by others (Maranzana et al., 2012). Supplementary coordination cues could originate from the integration of multiple real-time communication channels, such as chat, voice or video conferencing, as the following guideline suggests:

> ***SE7.*** *Integrate multiple channels for multimodal communication in the CST's visual workspace*

In terms of synchronous interaction, screen-sharing and remote desktop features are considered crucial in providing matching views for distant collaborators, assisted by parallel audio/video input for better coordination. Having active users or speakers show up on the screen is also important, as it facilitates - what is known in face-to-face conditions as – '*gaze awareness'* (Ishii & Kobayashi, 1992). CSTs can thus offer enhanced support for Design-oriented CoPS, through the direct integration of various communication channels (chat, video, screen-sharing), that can work in either synchronous or asynchronous interaction modes.

9.3.2 Interoperability

In this section, we expand the scope of investigation from activity-oriented (i.e. technical or visual design communication) to propose a general guideline regardless of the activity or tool. It focuses on augmenting CoP participation, by enabling its members to work with *spatially* and *relationally* proximal elements, be it visual artifacts, Q&As, programming code, messages, SN timelines, calendars, online resource repositories and so on. CoP members do not typically "live in" field-specific tools such as CSTs for example. Stewards should thus find out about the members' day-to-day tool preferences instead; these may typically include generic and specific productivity tools, communication apps, and most likely SNs. This poses a number of *governance* challenges for CoPs. Firstly, managing a collection of unrelated tools requires time and effort, and can be equally overwhelming for stewards and members. Secondly, this elevates the chance of redundancy (i.e. having similar information and resources repeated in different tools). Thirdly, it diffuses participation across all of them, leaving individual tools insufficiently populated, a phenomenon known as "practice intangibility" (Probst & Borzillo, 2008), and hence discouraging further interest and participation in the CoP.

Outcomes from this work show that CoP practice can significantly benefit from seamless *interoperability* between such day-to-day platforms and tools to provide a central point of access. Specifically, CoP stewards should aim to:

> ***SE8.*** *Enable interoperability between CSTs, generic productivity, SNs, and other tools included in the CoP's technology configuration*

On a practical level, this synergy requires technical knowhow for the customization of APIs (Application Programming Interface) that allow applications to inter-connect and extend their *functionality* and *access* to common data. Such efforts are becoming easier via new open standards utilizing W3C's Social Web Protocols (*W3C Launches for Social Web Application Interoperability*, n.d.) or following initiatives like the data transfer project (*Data Transfer Project*, n.d.). Explicitly, this project provides open-source code to enable seamless data portability (photos, mail, contacts, calendars, tasks) using publicly available APIs between platforms or service providers.

Adopting such strategies for CoP technology configurations can provide a unified experience similar to that of a natively consolidated platform: universal access and communication, customized tool functionality (i.e. CSTs.), and shared searchable resources via common *login* and *navigation*, to ensure spatial and relational proximity in the virtual space.

9.4 Social Design Implications

9.4.1 Power Relations: Trust, Competition and Accountability

We commence the analysis of the *social* component of the model with a top-level recommendation, and then proceed to break this down into targeted thematic units for more fine-grained understanding. Overall community stewards should:

> ***SO1***. *Aim for even distribution of power through the balance of trust, competition and accountability in the CoP*

Power equates the ability to define and claim knowledge in the practice; in short, *power* and *knowledge* imply each other in CoPs (Farnsworth et al., 2016; Roberts, 2006). As *power* entails prevalence in the *meaning-negotiation* processes, it is therefore analogous to the degree of participation in the CoP. It is, in essence, predominantly understood as owned by those who are more actively involved in the co-creation of *knowledge*.

In this work, the CoP included external (expert) members, who could ‘legitimately’ review and evaluate student work. However some degree of power asymmetries were recorded in the process. Through informal conversations, a*lumni mentors* in particular, reported experiencing a lack of power in their feedback (review) contributions; they required more detailed information on the projects at stake, such as the initial brief and requirements, the targeted academic outcomes, the specific feedback focus, as well as more contextual information, such as the teams' structure and the specific roles of their members. They suggested that this information needed to be communicated at the beginning, and be refreshed regularly throughout the practice. Although in this work, learners were responsible for supplying this information to mentors, findings suggested that this process should be monitored (by stewards); like for example, factoring this into a structured work deliverable that is assessed by the instructor and mentors alike, to ensure its effectiveness. It should occur, prior to the external members' involvement, to empower them and grant them with legitimacy in the practice. This work has inferred that the mentors' *power* in defining what constituted competence in the CoP, was compromised, due to lack of sufficient information. This also helps explain their lower participation levels in the SN platform. Consequently, CoP stewards should aim to:

> ***SO2.*** *Empower external CoP members with compound and in-depth information on their purpose and role, as well as about the other members in the practice*

Likewise, *industrial mentors* (clients), informally suggested that the time gaps between work-deliverable iterations were too wide, which resulted in more confusion and misalignment in terms of their focus and contribution. They, too, proposed that a detailed communication routine should be drafted and followed, as per the above guideline.

Aside of the external members' perspective, power asymmetries were also observed in *student-to-student* relationships. As discussed, *power*, the privilege of those most active in social groups – often becomes accrued in the hands of the *core* membership (Lave & Wenger, 1999b). Likewise, power was implicitly practiced by certain students, specifically those who exhibited higher levels of interest, motivation, eagerness to learn, and capability in dealing with subject-specific and generic learning activities. Related theory posits that while a strong core group is necessary for driving the community flow, it can also be steered to encourage - but not hinder - the engagement of those who might be shifting between peripheral and full participation. CoP stewards should thus seek to lead and *empower* more members into the active negotiation of meaning in the CoP. We draw from underlying literature to help explain and draw guidelines that manage the emergent imbalances of *power*, *trust* and *accountability,* as key social phenomena extracted from our analysis. We begin with *trust,* which claims dominance in the shaping of *power,* and vice versa. This study unpacked strong issues of *trust,* both in its *interpersonal* and *intrapersonal* forms.

9.4.1.1 Interpersonal (Peer) Trust

Lack of *interpersonal trust* entails suspicion of others' intentions, anticipation of opportunistic behavior, and tendencies of unhealthy competition (Hsu et al., 2007). In such cases, this signifies some form of 'moral hazard', whereby novices may well-intendedly share their work, while others grab the opportunity to copy from this work instead. This perceived threat to the members' intellectual property can thus inhibit participation in the CoP. Findings from this work suggest that community-wide project work reviews early on in the life of the practice, can in fact, mitigate this threat. Initiating early work crits for constructive peer reviews in the 'public eye', can help alleviate mistrust. Specifically CoP stewards are encouraged to:

> ***SO3.*** *Schedule regular synchronized deliverable reviews for peer teams commencing early on in the project cycle*

This *full-transparency* approach, inviting the early exposure and regular peer reviewing of work, lessens the chance of copying others' work, after being publicly scrutinized and encourages honesty instead. It helps eliminate behaviors of secrecy and mistrust that are often accompanied by the revelation of 'surprising end-events' (i.e. hiding work until it is fully completed), a strategy which is often practiced by competitive individuals.

Aside of its trust-balancing merit, this guideline also urges students to practice in giving constructive and fair feedback, that is supported by evidence, rather than arbitrary personal opinions. This process requires sound subject-level knowledge, objectivity, critical investigative skills and metacognitive aptitude. This is a much-required dimension of the students' pre-professional identities in the Design and surrounding industries.

The above guideline is feasible only if the entire class group follows a *common* schedule of synchronized deliverables, as part of a semester-long routine (see Table 5). On the other hand, it can be ‘eased’ by the variance of the *different* industry projects (i.e. content, purpose) and clients per team, a strategy that helps curb competition as proposed by the next guideline:

> ***SO4.*** *Assign different industry projects and clients to different CoP teams, ensuring that they require equal subject-level knowledge and technical competence*

This suggestion helps minimize antagonistic behavior and eliminates the highly likely comparisons of same-project implementations and outcomes between teams. That said, it is the instructor’s responsibility to ensure that there are equal-level requirements across all teams, regardless of their specific thematic foci. The project briefs thus need to be reviewed, adjusted and approved by the instructor, *prior to* the official assignment (*instructor-client* level adjustment), or *following* that (*instructor-team* level adjustment). Additionally, communicating the adjustment procedure to students, helps abolish student skepticism about uneven project criteria between teams.

Aside of mitigating *competitive behavior*, this approach offers another key benefit; it allows the propagation of different ‘industry-academia’ information streams to flow across the practice. Empirical data from the studies in this work indicate that the characteristics of different projects and clients, the distinct interactions and project-management activities, as well as the ensuing artifacts, were perceived as ‘highly interesting to experience’ by the members of different teams. As these occurred mostly in co-located settings, they also justify the purposes of guideline *SO5* below.

9.4.1.2 Intrapersonal Trust

Intrapersonal trust (related to self-efficacy) is influenced by *interpersonal trust*, both of which are associated with relations of *power* (Broom, 2015). Self-efficacy refers to personal beliefs about one’s capability to perform and generate positive outcomes in prospective situations, and is also influenced by various factors. Agreeing with previous work (Hsu et al., 2007), this work also confirmed two such key factors:

Competence: more competent and academically high-performers were found to have elevated levels of self-efficacy, being aware of their public (competence) status of them in the CoP. Through a history of effective competence demonstrations, it was easier for them to network with peers, and they presented higher levels of *collective intends* (i.e. assisting others) in the practice. In contrast, those with lower academic aptitude often felt vulnerable, in fear of exposing their ‘weaknesses’ in cop-wide settings (i.e. SN). In this regard, participation was found to be influenced by the surrounding levels of *competence* in the community.

Prior vicarious experiences and inhibitions: self-efficacy is also influenced by previous experiences and comparisons with the social context, like other peoples’ behaviors (“vicarious experience”) (Bandura et al., 1999).

A few such of cases were also uncovered by this research, regardless of an individual’s level of knowledge and skills. Reportedly a few student members had previously experienced social incidents which caused them embarrassment and feelings of intimidation, and led them to develop certain social inhibitions. These discouraged participation on behalf of these students, who abstained from social interactions to avoid similar outcomes, thus further compromising their levels of meaning negotiation and *power* in the practice (Alberola et al., 2016).

Data from student interviews in this work indicated useful propositions to help mitigate such issues. A primary step is to:

> ***SO5.*** *Aim for mixed-competence teams as the CoP’s working subgroups*

Teams generally tend to operate as entities of a collective identity. As it stands, self-formed teams often end up with one-sided (high/low) accumulation of competence, since ‘sameness’ is favored in team formations (Rubin, 2003; Tereshchenko et al., 2019). Yet, this form of sameness can lead to one-sided participation (i.e. the most competent members) in a CoP.

On the contrary, this phenomenon can be minimized, by leveraging the collective value of mixed-competence/attainment teams. These can enable students on the ‘lower-end’ to benefit from their association with more competent peers, enhancing their motivation, increasing their participation, and gradually empowering them as full members of the community (Tereshchenko et al., 2019). Critics of this method suggest that the downside to this may be that students on the higher end don’t get to ‘stretch’ their competence and skills enough. However, findings from this and other research claim that based on their elevated self-efficacy and motivation, high-attainers actually feel more challenged to work harder to help their 'less competent' team members progress with their work (Boaler, 2006). In fact that was – as participants argued - one of the disappointments of their CoP membership, since their peers did not invite enough opportunities to assist them in their learning. We argue that while this outcome is common across learning theories, it is critical for monitoring and balancing the power issues that are characteristic in education-based CoPs.

Another way to foster *inter* and *intra*-personal trust, particularly within blended learning contexts, as deduced by our and others' work, is to encourage sufficient *face-to-face* collaboration (in formal and informal settings), as a way to boost online participation (Aljuwaiber, 2016; Booth & Kellogg, 2015). Specifically stewards should:

> ***SO6.*** *Aim for community-wide face-to-face interaction early on and throughout the life of the community in order to boost online participation*

Aside of the value of face-to-face time, as an ice-breaking activity, there is more merit to this recommendation. Co-located settings can also support *explicit* and *implicit* knowledge co-creation in the form of accidental information 'spill-overs', which may transpire with more difficulty and more rarely in online settings. This is also strengthened by guidelines *SO3* and *SO4,* that aim to spread diverse information from different projects, reaching (intentionally or not) different teams (i.e. during class, homework sessions and break time) in collocated or online settings.

Finally, *inter* and *intra-personal* trust, from the external members' perspective, has a lot to gain from *geographical proximity*. Findings from the study indicated that face-to-face interaction between students and *alumni mentors* or *industrial experts* was necessary in order to 'put a face behind the name'. Even if all parties had access to each other's online information (public profiles, work portfolios), close proximity provided more comprehensive social cues and helped contextualize the meaning of the work deliverables, the *feedback* and the overall communication. Taking this into account, the CoP design was updated over the course of time (see Figure 17 and Figure 18), to include on-location/online expert presentations and mentoring sessions. These sparked more spontaneous behavior on behalf of students, who were observed to become more engaged in the practice following these, even those who initially admitted to a low level of identification with the CoP's subject (WDD).

9.4.1.3 Accountability

Accountability is a constitutive component of CoP practice, driven by its members' sense of *joint enterprise* and *mutual engagement*, and also corresponding to the degree of competence in the community. In other words, the higher their competence levels, the more *accountable* members feel towards their practice. Based on the previous discussions on these (see section 9.4.1), it is therefore also intertwined with the degree of *trust* and *power* in the community (E. Wenger, 1998).While it relies on innate interest and identification with the practice, *accountability* can still be encouraged through the steering of community activities by a CoP steward.

It should be noted that CoPs rely on the assumption that all members are guided by a *joint enterprise*, when in fact, students may not all be *uniformly* committed to the practice or 'area of endeavor', presenting "different levels of solidarity depending on their goals and values." (J. M. de Oliveira et al., 2015); explaining the unequal levels of participation in the CoP. It is also true that the degree of *identification* with the community's enterprise fluctuates depending on its members' personal preferences, interests, incentives, limitations, aspirations and circumstances (Probst & Borzillo, 2008). For instance, the use of complex or unknown tools in practice, may act at the expense of its members' time and effort, widening, in this way, the identification gap further. While this is predictable and common in related CSCL literature, some actions can improve *accountability* and help avoid the accumulation of *power* in the hands of a few, which may generate undesirable outcomes (i.e. compromised *inter/intra-personal trust*). We note that lack of accountability may be more prominent in exclusive virtual, rather than blended CoPs (Nilsson, 2019). A basic measure for this case is to:

SO7. *Limit the size of the CoP to enhance member accountability*

Individualistic tendencies and lack of accountability, are not easily 'hidden' or accepted in social groups with fewer participants. Smaller communities, especially those with face-to-face opportunities, are known to generate better understanding, closeness and healthier 'pressures' of participation, leading to better engagement, and hence, enhanced *accountability* (Nilsson, 2019). By contrast, *accountability* can become easily *diffused* in larger communities, especially those confined to an online practice only. This agrees with Wenger's (2002b) reasoning of larger communities being often divided in subgroups, based on *geographical* or specific *subject* criteria, in order to boost accountability and participation.

Finally, a measure to help improve the degree of accountability in a CoP further involves an aim to:

> ***SO8.*** *Highlight the intended responsibilities of each CoP role at the beginning and regularly throughout the life of the CoP*

Based on our findings, the role, objectives and responsibilities of CoP members get subdued and lost amongst the complexities and obligations of every-day work-life as well as due to people's *multi-memberships* across a landscape of practices (E. Wenger-Trayner et al., 2014). The threat to accountability is higher when members are *lightly* driven by the community's enterprise (low identification), for example when they do not aspire to gain expertise in a given area of interest (Morton, 2012; E. Wenger, 2010c). Regardless of the degree of identification, a reminder of members' benefits, contributions and actionable responsibilities in the practice, can act as a 'push' to their accountability (Borzillo, 2017). It is thus recommended that stewards provide, and make constant reminders of a plan of routine activities and expected outcomes by all members in the community, as Table 5 demonstrates.

9.5 Epistemic Design Implications

Epistemic guidelines involve the design of tasks that will guide the learning *activity* and the related outcomes (P. Goodyear & Carvalho, 2016). The three prominent themes extracted relating to this component of guidelines in the study, involve matters of *time*, strategies of *feedback*, and the *roles* and *purpose of external members* in the CoP. Several implications are considered, organized and presented under each theme.

9.5.1 Time

Time is a fundamental component of learning in CoPs, since Wenger (Farnsworth et al., 2016) perceives the transformation of members' identities as a journey through *time* and *space* (see section 2.3.5). Under the lens of social learning, *time* contributes to the evolution of novices' knowledge and competence through CoP practice. Time can nonetheless act at the expense of learning, if it is not effectively managed toward the epistemic objectives of the CoP. It is also crucial, when the CoP includes people with memberships in different communities, across a *landscape* of practices (see section 2.3.6).

This research is underpinned by work which suggests that collaborative learning *activities* cannot be designed or fixed prior to their enactment (P. Goodyear & Carvalho, 2016). Instead these are emergent (in practice) through the constant and autonomous co-configuration of the learning components by the participating members or the designers (i.e. educators). Yet, an initial epistemic structure can to-some-degree *guide* the real-life activities that ensue. These should be decided upon collectively between all interested parties – in other words - those who are invested in the practice. Within the scope of this study, 'interested parties' refers to the learners as members of the CoP. Ideally, the *epistemic* ecology should be co-designed by representatives from all CoP roles (i.e. alumni mentors, experts). In doing so, the members' preferences or limitations regarding the platforms and tools, the interactions and teamwork, the deliverables and schedules (i.e. what is *beneficial* and *feasible*), and the communication plan in place can be thoroughly understood or adjusted to match the preferences of each role. CoP stewards (as instructors in this case) should thus:

> ***EP1.*** *Invite community-wide participation in the design of the learning ecology prior to its enactment*

This step is crucial as it primarily helps educators, experts and students define their learning, communication and collaboration needs, and using these to co-design a suitable and sustainable ecology; an ecology of *tasks, people, tools and places*, as the key components of practice (P. Goodyear & Carvalho, 2016). For instance, in this work, *alumni mentors* retrospectively suggested a mixed feedback approach, specifically an intermittent '*mentor-to-single-team' and* '*mentor-to-many'* reviewing strategy. This stemmed from their observation that many of their comments applied to the issues encountered across all teams. Additionally, video-conferencing - instead of written communication – was deemed more appropriate at times (i.e. when real-time communication was important) so as to clarify the meaning of reviews, at specific project stages. This suggestion was unexpected, contrary to the steward's initial efforts to avoid overloading mentors (since synchronous activities demand availability and better coordination), due to their busy work-schedules. In this respect, co-designing CoP-based tasks with external members can thus help improve the epistemic plan based on specific suggestions and preferences. It also ensures that the relevance, purpose and properties of the ecology are equally understood by all CoP members (Novakovich et al., 2017).

In agreement with the ACAD framework and based on findings, we posit that this process can be further enhanced through *visual representations* (i.e. sketches, network diagrams, tables) (see Table 5 and Figure 22). Such artifacts can help visualize the 'mechanics' of the process, illustrating how CoP-driven and academic activities coincide (see also guideline *EP4*). These can also serve as *reified artifacts* of the practice, that can be referred to by CoP members at any time (i.e. for clarifications or guidance). Yet, most importantly, visual artifacts are inherently bound to the Design and relevant practices (HCI, architecture, engineering), and constitute critical means of communication within Design teams. Stewards and/or instructors should therefore:

> ***EP2.*** *Introduce visual representations to simplify the epistemic ecology and clarify its practical implications early on in the life of the CoP*

It is equally important that this ecology is amply pilot-tested, prior to its enactment, to uncover possible issues and to allow for early *co-configurations* to best serve the practice. It is thus reasonable to:

> ***EP3.*** *Allow for sufficient time to pilot-test the epistemic ecology prior to the commencement of critical CoP-based learning practices*

Time is also significant for achieving sound epistemic outcomes through a planned interweaving of the curriculum and CoP-based practice; their learning activities and objectives should coincide. For instance, within the scope of WDD (see section 3.2.3.1), classroom practice concerning the technical development of a website's GUI should allow for substantial time ahead of the deadline for the respective deliverables, so as to be reviewed by the alumni mentors in the CoP. Likewise, instruction on time-management methods (i.e. Gantt-charting), should occur close before the deadline for the delivery of the project plan to the industrial mentors (clients).

This approach facilitates an intertwined form of knowledge transfer; it highlights the significance and currency of the curriculum themes, and enriches them with the real *situated* experiences that emerge in the CoP. This planned timing is reflected in the following guideline:

> ***EP4.*** *Plan the academic curriculum to coincide – thematically and temporally - with CoP-based activities*

In conjunction with guidelines *EP2* and *EP3* above, CoP stewards should carefully plan the CoP's project practice schedule to leverage its full learning potential.

Albeit being a temporally-driven construct too, *feedback*-related implications are discussed as part of the following section.

9.5.2 Feedback

One of the crucial aims of the cross-organizational model was to provide students with the chance to receive *authentic feedback* from external industry members (alumni and industrial mentors). Hence the following key guideline:

> ***EP5.*** *Aim for regular feedback and evaluation of student work from expert CoP members to enrich the academic feedback processes*

This feedback process naturally resulted in the accumulation of a large volume of comments. Although highly beneficial, feedback was often perceived as extensive, ambiguous or conflicting by students (see section 6.3.4). Interestingly, virtual mentors confirmed this outcome too, stressing the need for better prior agreement on the *focus* (areas of interest) and *volume* of feedback. On the contrary, they perceived diversity and conflict in feedback as beneficial and highly representative of future work-based scenarios.

As such, on the one hand, the findings of this work indicated that students as CoP members were forced to counteract the feedback-related challenges by practicing better regulation, which eventually led to significantly higher epistemic outcomes (see section 6.4.2). On the other, the constructive value of expert feedback was a positive predictor of *achievement*, only when this was delivered in *plain* – rather than negative - tones. This outcome denotes that feedback can be curated to ensure that *focus*, *volume* and *tone* are appropriated to the epistemic objectives of the study. More precisely, instructors and CoP stewards should jointly:

> ***EP6.*** *Proactively negotiate the focus, amount and tone of feedback with external CoP contributors*

Guided by the epistemic objectives, specific recommendations should be outlined by the course instructor in advance, to define: a) the *thematic focus*, i.e. the visual, technical/functionality, usability or other properties of the work, b) the *volume*, i.e. a pre-defined word-range, and/or a plan that combines single and multiple mentor reviews per team and vice versa, and c) the *tone*: suggesting the use of recommendations, rather than plain judgements, and neutral - rather than negative - tones in the feedback.

Furthermore, the learners' responses to the reviewers were limited, even in the cases when they were initially unable to comprehend their comments. As previously mentioned, although this had evidently pushed teams for better *learning regulation*, feedback should be articulated to invite responses (i.e. posing questions), and generate constructive negotiations around work matters. It is also equally critical that these negotiations are visible to everyone in the community. For instance, both alumni and industrial mentors stressed the benefits of going through each other's reviews in order to a) identify common factors in their judgements and hence, confirm or decline the correctness of their reviews, and b) avoid repetition of comments and save time. In the same way, learners can also benefit from other teams' *feedback-related* conversations. Hence, the next guideline ensues:

> ***EP7.*** *Articulate comments appropriately to encourage reciprocal feedback for CoP-wide access*

9.5.3 The Purpose of Expert CoP Members

The role of external CoP members, is critical in cross-organizational CoPs. In this study we were able to infer that they: a) promote a sense of identification with the practice's joint enterprise and set the three *modes of belonging* into gear, b) they provide the necessary authentic diversity in the evaluation and *feedback* through their multiple industry perspectives and c) they enable *brokering*, in that they bring along *boundary elements* from different practice (E. Wenger, 1998). The benefits and ensuing guidelines regarding each of these outcomes are described below, but we begin with a generic recommendation that applies to all roles:

> ***EP8.*** *Invite industry members with various degrees of expertise to provide briefs, expert insights, feedback and evaluation for student work*

The guideline above should be practiced in collaboration with the module/course instructor and necessitates effort to orient the external members prior to their involvement in the CoP. We proceed to analyze guideline *EP8* further, under the lens of each individual role.

9.5.3.1 Alumni Mentors

Wenger (2014) posited that the concept of CoPs was formed based on the need to decrease the distance between *masters* and *novices* (suggested by traditional *apprenticeship* theories). The perception of masters, as the 'big figures' and the competence-gap between them and novices, can compromise the meaning-negotiation processes. Instead, experts who are 'just a little ahead', are more accessible for assistance. By negotiating more *proximal* (understandable) meanings, novices get the chance to gradually co-create further knowledge and competence in the practice. It is therefore proposed that community stewards aim to:

> ***EP9.*** *Recruit recent graduates for the role of alumni mentors in the CoP*

The word *recent* refers to both *time* and *relational* dimensions. Specifically, alumni mentors suggested that the *recency* between them and learners, also manifested in *relational proximity*; that is the degree to which individuals relate based on "affinity and similarity" (Moodysson & Jonsson, 2007b). Afterall, both member roles share similar pedagogical backgrounds, theoretical foci and instructional practices, being not too far apart from each other. On the contrary, the longer the time since graduation, the wider the relational gap, and the lower the degree of alignment in the ways o*f knowing* (E. Wenger, 2010b).

9.5.3.2 Industrial Experts

Industrial experts should be involved in the CoP, not as distant *symbols* of achievement but as active real-life human capital, accessible at close proximity. This can enable a deeper level of identification on behalf of local members, through a process of *imagination* and *alignment* with the global practices (i.e. industry). It is thus critical for novices to have *legitimate* access to the history of these experts, particularly their academic-professional career trajectories, even if these were not identical to theirs (Morton, 2012). Secondly, it is important that community experts share real-life facts and the lived experiences of the present, as well as the projected status of the professional practice in the local and global industries. This highly valued 'inside information' cannot evidently be found via other sources; yet, it is crucial for young graduates, who are making their transition into the broader practice. Thus, aside of evaluation, a critical dimension of the experts' involvement should be to:

> ***EP10.*** *Aim for sharing expert trajectories and 'inside' information about the industrial practice*

This work's findings confirm that novices identified with the experts' trajectories through both the positive and negative events they presented. This transformative process of *identification* with the trajectories of the practice (or across multiple practices), urged leaners to become realistically 'grounded' in both the favorable (achievements and successes) and unfavorable (challenges and burdens) truths it involved. With that in mind, the very presence of experts in the CoP confirms the positive finish line of a trajectory, sending optimistic messages to novices at the start. It consequently steers the process of *imagination* and *alignment* as two key *modes of belonging*. First, it sparks the possibility of similar *imagined* outcomes (i.e. career, status, achievement) for novices. Then, it enables them to identify the steps required, to begin shaping their own trajectories based on relevant guidance (i.e. work towards building a professional portfolio during semester breaks). Finally, through the intense *meaning-negotiations* that transpire, the *identity* is incrementally transformed to *align* with the professional (broader) practice, as this is mediated through the experts' contribution in the CoP.

9.5.3.3 Industrial Mentors (clients)

The presence of real-life *clients* is crucial in cross-organizational CoPs, not only for assigning authentic projects, but also for informing the local practice with diverse industry information, based on the various other practices they belong to. For instance, their feedback does not abide to the correct (Design) terminology, it is often messy, unfavorable or in conflict with theoretical principles. Learning to deal with, counteracting or integrating this feedback into the work, in a way that 'both clients and designers win', is an important mitigation skill for the real-world practice. Students will soon face such conflicting decisions, with their professional reputation and financial statuses at stake. Fictitious clients and projects are thus not only meaningless, but also downright incompatible with the cross-organizational objectives. By contrast, real-life industry clients are of primary importance in *situated* social learning approaches of this type. Community stewards should thus seek to:

> ***EP11.*** *Always include real industry clients & authentic projects to guide the CoP-based activities*

As mentioned above (*EP8*), this requires groundwork on behalf of educators and CoP stewards; that is drafting a list of documents and necessary information to recruit, guide and assist industrial mentors for the purpose of learning. These should include documentation explaining the CoP ecology (set epistemic and social design, role responsibilities), various communication templates (i.e. invitations, letters of intent for stakeholders, diagrams), online forms for required client and project information (contracts), and a realistic communication and deliverables plan based on each role's availability (see Table 5).

9.6 The Cross-organizational CoP Model

Below we provide two ways of summarizing our research outcomes with respect to the cross-organizational CoP model (see Figure 31):

a) a diagram of the three key guideline sets, these being the **Set** (technology configuration), the **Social** (social interactions), and the **Epistemic** (design of learning activities) components

b) a table for each component in Appendix I, containing the work's *thematic findings* and respective *guidelines*, related *bibliographic* evidence, and *instructional interventions*, together with appropriate *evaluation measures* that can be employed in a cross-organizational CoP-based learning ecology. We believe that both provide solid guidance and serve as a supportive knowledge base for the integration of cross-organizational CoPs in the HE Design studies, with an aim to enhance learning.

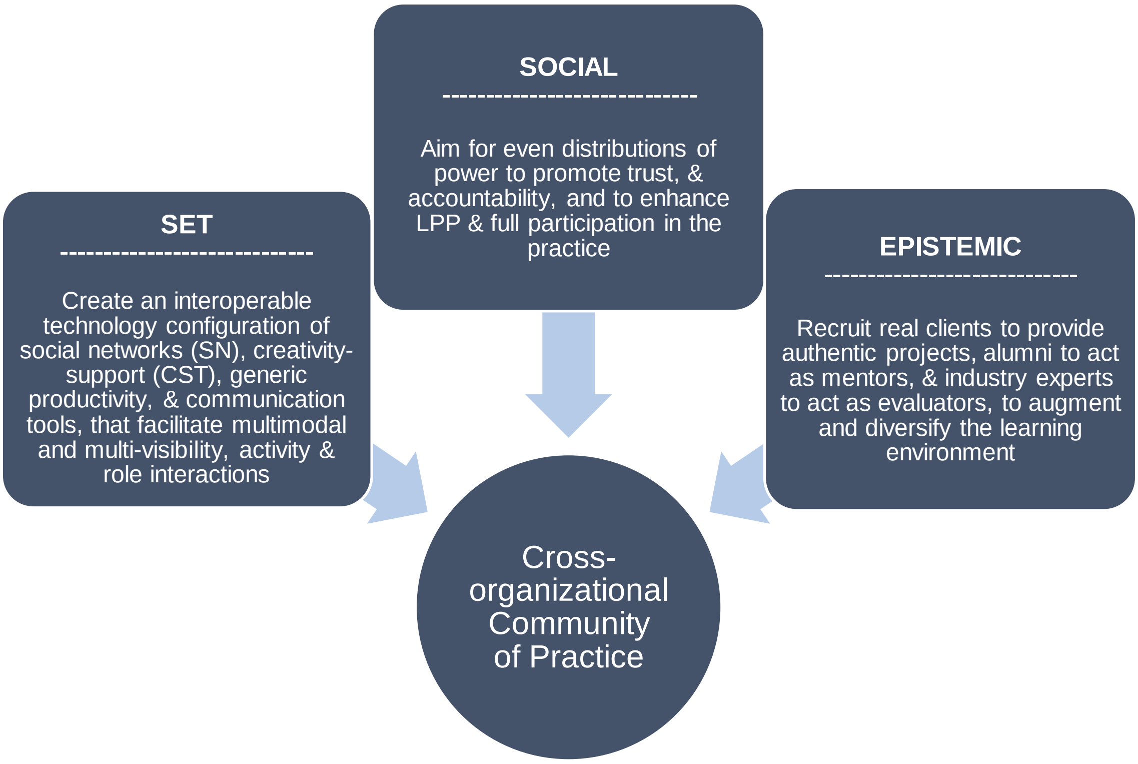


Figure 31: The Cross-organizational CoP Model

9.7 Summary

This chapter presented the sixth and final study of the research which falls under phase 3, *Integration*. This study addressed the call for *governance mechanisms* for CoPs of a specific *structure* and *scale* (cross-organizational), *scope* (Design studies), and *purpose* (epistemic and creative outcomes, soft skills, vocational relevance, and pre-professional identity formation). Following the ACAD (analytical framework) structure, it concluded a total of eight principles for the *Set* component, eight for the *Social* component, and eleven for the *Epistemic* component. These principles were grouped into thematic units and are discussed in the context of related theoretical concepts in the next chapter (section).

10 Discussion

This work is guided by two overarching research aims. These are:

a) to provide comprehensive evidence of the CoP's ecology *design*, *enactment* and *evaluation*, from the *social, epistemic* and *technology* perspectives. Through this evidence, this work, effectively, validates the *cross-organizational CoP* model within the context of Design studies in HE.

b) to derive practical *governance implications* by offering an affordable and transferable *cross-organizational model* for a CoP-based learning ecology in the HE Design curriculum.

In order to address these two overarching research aims, this chapter is divided into six parts. The first part explains how the six individual studies, conducted across the three research phases, address their primary *research objectives* (see Figure 32), through a summary of their findings. The second part provides a *critical discussion* of the proposed design implications, based on the associations and distinctions between them and foundational CoP theory and related literature. As the research's objectives were instigated by relevant knowledge gaps, the third and fourth parts present its respective *contributions* to CoP and Creativity literature. Finally, the last two parts of this chapter summarize the *limitations* of this work and provide directions for *future research*.

10.1 Addressing the Research Objectives

The primary research objectives presented by phase and study can be seen in Figure 32. We discuss these individually in the next sub-sections (10.1.1 through to 10.1.6).

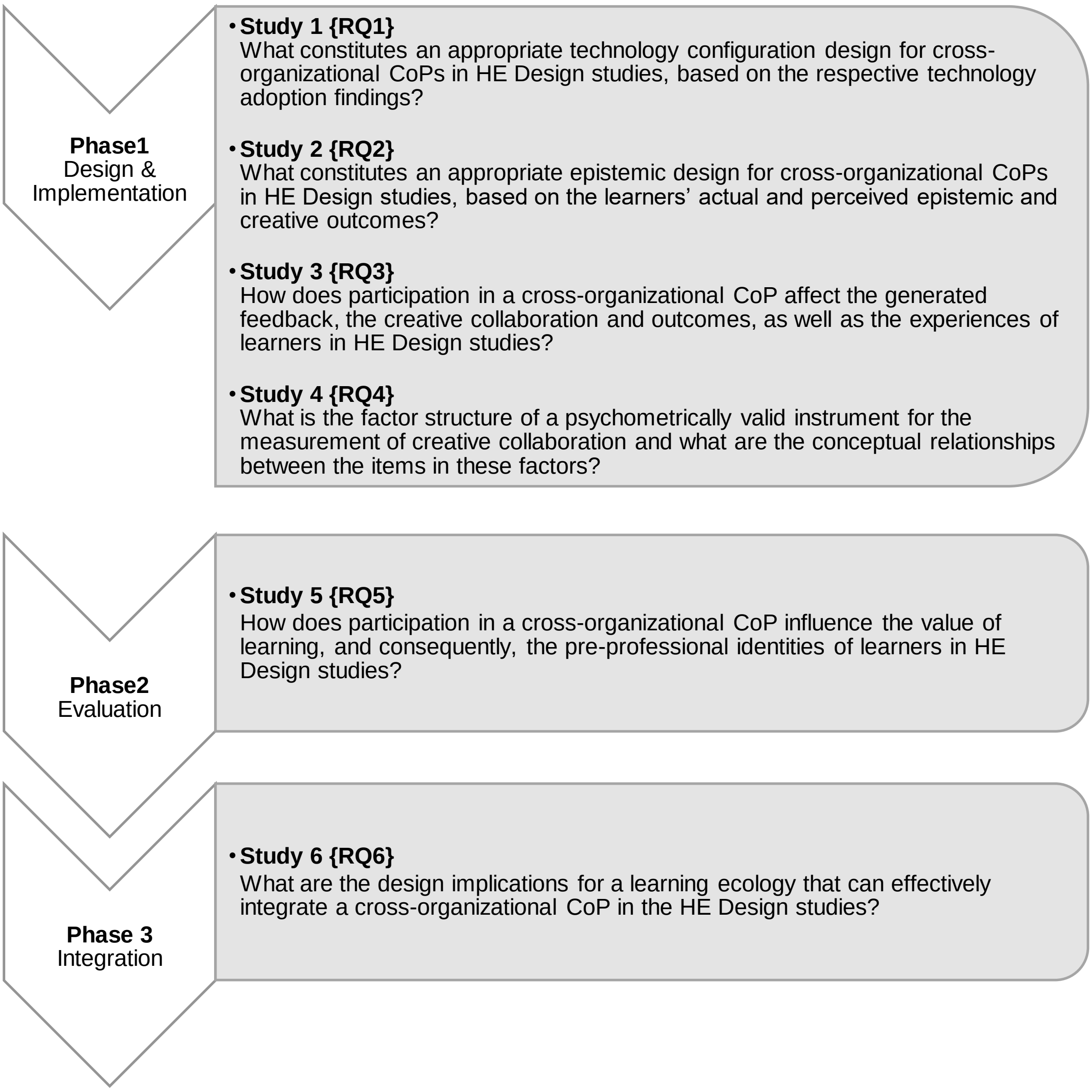


Figure 32: Phases, individual studies and research questions

10.1.1 [RQ1] - What Constitutes an Appropriate Technology Configuration Design for Cross-Organizational CoPs in HE Design Studies, Based on the Respective Technology Adoption Findings?

The first study of phase **1** examined the design of a technology configuration that was appropriate for supporting a cross-organizational CoP in the Design and related studies. To address this objective the researchers drew from a) the foundational VCoP theory (E. Wenger et al., 2009), b) the technology needs of relevant Design disciplines, and c) followed criteria that warranted the use of free, affordable and familiar technologies, minimizing in this way, any technical or administration threats to member participation. The technology configuration design comprised tools that supported productivity (Google Drive, Google Docs), communication and networking (email clients, Facebook Groups, chat), creativity-support (Adobe Suite, ConceptBoard, Axure), webpage-integrated feedback (Hypothes.is), online portfolio platforms (Behance), and learning management systems (Moodle).

The study also reported on the type and level of technology adoption, focusing on the learner's perspective. It specifically uncovered the critical importance of *user awareness* in synchronous visual (creativity-support) tools, and particularly in terms of the collaborators' *role* and *identity*, their *position* and *activities*, and the *timing* of their occurrence in the virtual space. Findings also indicated that virtual spaces for cross-organizational CoPs should facilitate various embedded communication channels (i.e. audio/video conferencing, chat), multiple user roles, visibility, and activity privileges, as well as interoperability with social networking platforms, with an aim to access common data and functionality through a centralized system.

10.1.2 [RQ2] - What Constitutes an Appropriate Epistemic Design for Cross-Organizational CoPs in HE Design Studies, Based on the Learners' Actual and Perceived Epistemic and Creative Outcomes?

Following the technology configuration setup and analysis, the second study of phase **1** explored the cross-organizational CoP's impact on the learners' *creative outcomes* and perceived *epistemic cognition*. The study presented findings which indicate that participation in the CoP had significant positive effects on the students' knowledge gains (final exams) and creative outcomes (produced websites). These were extracted based on a comparison between an experimental (students who participated in the CoP), and a control group (students in a traditional learning environment).

Further evidence with a focus on the students' epistemic cognition, extracted three prominent themes as the key motivators behind these positive outcomes. They concerned the *authentic* exchanges and interactions with the external (industry) members of the CoP, and as a result, the creative *constraints* that emerged through the practice, the *prospects* of a broader *audience* for the students' achieved outcomes (website), and the promising outlook on their future careers, through their participation in the CoP.

10.1.3 [RQ3] - How Does Participation in a Cross-organizational CoP Affect the Generated Feedback, the Creative Collaboration and Outcomes, as well as the Experiences of Learners in HE Design Studies?

The third study of phase **1** investigated the social exchanges and *creative collaboration* of students (in team-based and CoP-wide contexts) in the cross-organizational CoP, which consequently led to enhanced *creative* outcomes. Specifically, the study focused on *feedback* – as a key component of the CoP's social exchanges - that was delivered by the external members of the CoP (alumni mentors), following the review of student outcomes throughout the semester.

The study's findings unpacked a twofold effect on learners. On the one hand, the critical feedback increased both the complexity of the work and the expected level of outcomes, and consequently imposed added time pressures, affecting the learners' perception of their team's performance. On the other hand, feedback appeared to generate better creative outcomes, while improving the teams' metacognitive and learning regulation activities. Furthermore, it enabled learners to pragmatically realize their status within the broader geography of the professional practice, and thus, to reconfigure their achievement goals accordingly.

10.1.4 [RQ4] - What is the Factor Structure of a Psychometrically-Valid Instrument for the Measurement of Creative Collaboration, and What Are the Conceptual Relationships Between the Items in These Factors?

The fourth study of phase **1** concerned *creativity* and *collaboration*, as the two critical skills expected of graduates transitioning into the digital creative industries today. The focus of this study was to validate the psychometric properties of an existing instrument, the Assessment Scale for Creative Collaboration (ASCC), which measures perceptions of *creative collaboration* in teams in blended or online learning/work settings. To do so, it recruited 236 under and post-graduate students with previous experience in group projects, to self-evaluate their creative collaboration experiences using the ASCC. The findings of Exploratory Factor Analysis (EFA) indicated a three-factor structure (21 items) comprising the '*Synergistic Social Collaboration'*, '*Distributed Creativity*', and '*Time Regulation and Achievement*' factors, with satisfactory reliability scores. The study also discussed the findings of the EFA, by drawing conceptual associations between the different items in each factor, drawing on underlying literature.

The study's findings were important within the scope of this research, as the ASCC was employed to measure the creative collaboration of students who participated in the cross-organizational CoP in study **3**.

10.1.5 [RQ5] - How Does participation in a Cross-organizational CoP Influence the Value of Learning, and Consequently, the Pre-professional Identities of Learners in HE Design Studies?

Drawing from the findings of the four studies in phase **1**, combined with new evidence from phase **2**, this study analyzed and evaluated the *value of learning,* that resulted from the students' participation in the cross-organizational CoP, over the course of one academic year.

The study employed Wenger et al.s' (2011) *Value Creation framework* to analyze and classify the value of learning according to its five cycles, namely the 'immediate', 'potential', 'applied', 'realized', and 'reframed' cycles. The findings indicated a strong *immediate* learning value, based on the great number of learning and collaboration exchanges recorded in the CoP. These generated new insights, based on the relationships that emerged, and the artifacts that were co-created in the CoP, signifying learning of *potential* value. The effective transfer of knowledge into the academic practice was confirmed by the significant improvements in the student performances, which indicate a strong impact of both *applied* and *realized* learning value. Outcomes also pointed to a shift in the learners' perspectives, by pragmatically transforming their perceptions of achievement and orientating them towards the professional practice, denoting a *reframed* form of value creation. The sum of these reflected a modulation of identity, driven by the learners' prospective transition, enculturation and evolution within the broader professional landscape of their practice.

10.1.6 [RQ6] - What are the Design Implications for a Learning Ecology that Can Effectively Integrate a Cross-Organizational CoP in the HE Design Studies?

Drawing from the sum of findings in phases **1** and **2**, this study extracted practical governance implications for researchers and practitioners, as community administrators, who wish to integrate and study cross-organizational CoPs in the areas of HE Design disciplines. These guidelines were derived from both the effective as well as the challenging phenomena that surfaced during the design and enactment of the CoP, that were framed by the three ACAD components, namely the *Set* (technology), *Social* and *Epistemic* components. The guidelines were grouped into different themes under each component, in order to better explain their meaning and purpose in the model.

The CoP governance model is presented in Table 50 in chapter 9. The themes of guidelines under the *Set* component concerned *practical* and *socio-emotional* issues in technology-mediated CoP environments, as well as respective considerations for CoPs that are oriented toward *technical* and *visual design* communication. *Interoperability* also surfaced as an important design implication under the same component.

Guideline themes under the *Social* component involved the management of *power* relations, which are influenced by the levels of knowledge and competence, identification with, and accountability towards the CoP's practice, with considerable effects on its members' trust and competition levels.

Finally, guideline themes under the *Epistemic* component reflected the criticality of *time*, as a determining factor for the co-evolution of knowledge, competence, and the transformation of members' *identity*, the importance of *feedback,* as a boundary object which infuses the practice with diverse information across a landscape of practices, and the key *boundary relationships* between the learners and the expert members of the CoP, which activate the three modes of belonging, namely, engagement, imagination, and alignment, for learners as prospective graduates.

10.2 Critical Discussion of the Design Implications

Guided by the overarching aim to address the knowledge gap concerning *structure, scope,* and *purpose-specific* implications for CoPs (Amin & Roberts, 2008; U. Smith et al., 2017; Spagnoletti et al., 2015), we proceed to critically discuss the guidelines proposed in the previous chapter (see section 9.2). We corroborate the guidelines' *significance* by a) outlining their value and contribution through connections or contrasts between them and foundational CoP theory, as well as, related research, and b) outlining their combined value, through their correspondence and inter-supportive role toward other guidelines of the Set, Social, Epistemic - components in the model.

To further support the design model, this work proposes specific examples of *practical interventions* for each guideline set, as well as possible methods of *measurement* and *evaluation* (see Appendix I), to help simplify their transfer into various instructional settings. Finally, a list of suitable available technology tools for the various activities of the Design-oriented CoP practice is offered in Appendix II.

We begin by discussing the Set guidelines, which refer to the CoP's technology configuration, in this work.

10.2.1 Set Design Implications

In this research we have inferred several Set-related themes that originate from empirical evidence, both in terms of the effective enactment, as well as the limitations, of *practical* (i.e. *usability*) and *affective* (socio-emotional) nature, that emerged from the technology design and adoption analysis. Our findings, particularly in terms of limitations, coincided with several studies in the area of technology-supported communities, in both educational and organizational CoP literature and concerned: fear of exposure and vulnerability ('virtual panopticon' (Brass & Mecoli, 2011; Waycott et al., 2017), criticism (Baek et al., 2008), resistance ('resistive agency' (Novakovich et al., 2017)), negative self-comparisons ('unhelpful comparisons' (Crossouard & Pryor, 2008)), competition ('dishonest intentions' (Chang et al., 2008)), minimal identification and participation ('lack of identification' (Probst & Borzillo, 2008)), lack of ownership ('lack of authorial identity' (Dennen, 2016; Waycott et al., 2017)), and language barriers (Frith, 2014; C. S. Huang et al., 2016).

In response, the Set guidelines propose *interoperability* amongst the different tools and platforms that support the CoP practice, and focus on the enablement of effective *practical, technical* and *visual design*-oriented collaboration, by minimizing the negative *socio-emotional* factors that can compromise CoP practice. The next sections discuss these themes.

10.2.1.1 Interoperability

This work inferred that the design for learning for both pre-existing or emergent CoPs should be primarily concerned with integrating a customary choice of tools that members prefer, as they deem important, are familiar with by having previously used it to facilitate their activities (Mavri et al., 2019a; E. Wenger et al., 2009). This is supported by guideline *SE1*, which also lays the groundwork for guideline *SE8*; this refers to the critical mass of *interoperable* technologies that CoPs need to adopt for the support of their Design-oriented practice. Guideline *SE1* also relies on the enactment of guidelines *EP1*, *EP2* and *EP3*, which suggest early *community-wide* involvement in the design and testing of the CoP's learning ecology. In this sense, it effectively applies the theory's primary *local-global* duality (see section 2.3.3), in that it equally empowers the *local* (learners, faculty, alumni mentors) and the *global* (industrial experts, clients) members of the CoP to design and steer their practice, aligning with the foundational CoP theory (E. Wenger, 1998).

With regard to *interoperability (SE8)*, our work agrees with De Moore's (2015) who warns that interoperability attempts are not to be thought of as 'technological quick fixes'. On the contrary, design for interoperability should be informed by *reusable heuristics* that originate from empirical technology-adoption patterns, as performed in this research. To further support our findings, we propose that efforts for data portability and interoperability in CoPs are informed by standardized guidelines for linked social data such as: the Data Transfer Project (DTP, 2018), W3C Social Web Protocols (W3C, 2017), the Solid Project (MIT, n.d.) and the General Data Privacy Regulation (GDPR).

10.2.1.2 Practical and Technical Considerations

Practical considerations in the context of CoP technology configuration, reflect implications for *field-specific* tool functionality and usability (i.e. technical communication in SNs, visual interactions in CSTs). While formerly discussed in non-

CoP literature (Dillenbourg et al., 2009; Gutwin et al., 1996, 1996; Suthers & Hundhausen, 2003) this work provides empirical evidence on the significance of system support for multiple *roles, permissions,* and *visibility* (*SE5*), *workspace awareness* (*SE6*), and *multi-channel* communication (*SE7*), from a CoP perspective.

The particular value of these guidelines, lies in their purpose to bolster the three constitutive dimensions of coherence in the CoP practice – namely *mutual engagement*, *joint enterprise*, and *shared repertoire* (E. Wenger, 1998). Specifically, the guidelines are meant to provide the basis for a) supporting the full complexity of 'doing things together' (*mutual engagement*), b) strengthening and perpetuating a common enterprise that can be flexibly and safely negotiated through tools that allow for this to happen (*joined enterprise*), and c) enabling the gradual development and use of a shared language (terminology, resources, symbols) amongst collaborators in a virtual practice (*shared repertoire*). Additionally, these guidelines aim to resemble dynamic face-to-face actions which allow collaborators to be aware of and have fluid control over *who, where* and *what* they interact with; at the same time they aim to enhance those unique technology affordances that may not available in face-to-face contexts (i.e. copy/paste, co-editing) (Dillenbourg et al., 2009).

The sum of the above reflects and propagates a fundamental notion of CoPs, which constitutes them as social groups that can fluidly learn together, through social cross-linkages, rather than relying on the bounded relationship of an apprentice and a master (E. Wenger, 2011).

It is important to note here that our findings concur with relevant work suggesting that everyone (*human*) and everything (*non-human*, like tools and interfaces) in the community may present *resistive agency* (Novakovich et al., 2017; Roberts, 2006). A 'non-human' form of resistance reflects the *usability* barriers encountered, for instance, in the technical communication (i.e. code sharing) activities in this work. Drawing from relevant work on *technical communication* in community platforms (S.-H. Yang, 2016), guideline *SE2* aims to address such restrictions by advising the integration of *technical Q&A functionality,* that has been proven effective for CoPs in similar epistemic fields.

10.2.1.3 Socio-Emotional Considerations

Another challenge encountered by the participants in this research intervention, the *language* barriers that compromise all, yet particularly, *technical communication* (i.e. code sharing) in CoPs. While this is anticipated of non-native language (i.e. English) speakers, it still emphasizes the critical need for skills in synthesizing accurate technical queries and responses, for CoPs in the Design and adjacent areas. Our findings agree with evidence from participation in other technical communities that are likewise prone to such language-related problems (Frith, 2014). Stackoverflow (a public technical 'question-and-answer' community) for instance, has repeatedly received criticism for being an 'intimidating elitist space' which marginalizes members (typically novices), primarily due to their poor communicative skills, among other issues (Hanlon, 2018). The model offered in this work suggests that such issues can be proactively addressed in guideline *SE4* (training students in technical writing) in order to ensure effective technical communication in the CoP practice.

We also posit that the significance of guideline *SE4* does not only concern *technical* but also generic *social*, or professional communication. It is usually associated with an aptitude for online communication with diverse audiences and knowledge in managing written web-content effectively (searching, filtering, extracting, editing data). These are evidently critical skills for the development of learners' *pre-professional* and *professional* identities, and consequently augment their employability prospects following university (Jackson, 2016).

Our findings, in this respect coincide with those from Novakovich et al. (2017), who identified a gap between students' *every day,* versus their *professional* communication practices on social networks (SN). To cultivate social communication (writing) skills, the integration of SNs, as a key component in the academic and CoP-based practices, is thus necessary. In line with this evidence and drawing from our findings, these directions are effectively included in guideline *SE1* (i.e. integrate SNs in the CoP technology configuration).

However, the significance of the aforementioned (as well as the entire Set collection) guidelines, extends beyond addressing practical (technical) or skills-based (language and SN skills) issues, with the aim to 'equalize' the power imbalances and the respective socio-emotional repercussions that these carry, which may affect participation in a CoP. Uneven distributions of *power* are bound to emerge in CoPs (especially VCoPs), as they include uneven authority between members who present *knowledge, competence* and *accountability* toward the practice, versus those who don't (Farnsworth et al., 2016). Findings from this work agree with existing research, which reports higher participation levels from a core group of learners (usually those with higher academic achievements), versus the rest, in a CoP (Cundill et al., 2015; Knaus & Callcott, 2017; Smith IV et al., 2020; E. Wenger et al., 2002b). A heavier form of engagement in the practice gives members a dominant role in the *meaning-negotiation* and *knowledge creation* processes in the community. While CoPs rely – to a certain degree – on this phenomenon in order to drive social learning, extreme differences in participation, relating to competence and power, may often become overwhelming for less competent members; they can specifically lead to negative socio-emotional reactions (i.e. compromised *inter* and *intrapersonal trust*) as discussed in the previous chapter. In order to create healthy "opportunities for learning" (E. Wenger, 1998) by encouraging everyone to make their own claims to competence in the community, these power imbalances can be proactively mitigated by following guidelines SE2, SE3 and SE4.

Power imbalances, socio-emotional issues, and participation are also addressed by the *SE5* and *SE7* guidelines. That is, the capacity to *narrow* or *expand* the social audience during CoP practice, and hence to normalize power in alternative ways, is equally important, as our findings indicate. For instance, emotional expression might be easier to transpire with less people, and smaller groups may be preferred at times, since they allow for a "mixture of intimacy and openness to inquiry" (E. Wenger et al., 2002a) during practice. This does not act at the expense of a 'collective' practice. In fact, it stresses the need for CoP stewards to facilitate public, as well as, private modes of CoP communication, as per the original theory.

Technology plays a key role in this, by adopting a flexible and modular configuration (as SE5 suggests). In this way, community-wide tools (i.e. SN, CSTs) can cater for narrower or wider types of access, through *team-based*, *community-wide* (local), and *public* (global) settings, as preferred. The *narrow access* mode supports the needs of CoP members for direct private (one-to-one) or semi-private (team) exchanges, while at the same time, offers them the opportunity to practice their communication skills for wider-audience contexts (Rifkin et al., 2010; Waycott et al., 2017). Likewise, the *CoP-wide* or *public* modes, provide access to larger-audience activities whenever required. Through LPP, this mode also allows individuals to gradually locate themselves in the practice (or in a landscape of connected practices), for the time when they feel ready for fuller participation in the CoP (Cundill et al., 2015).

From a theoretical standpoint, the contribution of *SE5* and SE7 guidelines is manifold. First, they take into account and enact Wenger's (1998) concept of the principal *local*/*global* duality, and address its balance as critical for the practice. In this way the CoP can enable fluid interactions of both *local* and *global* scope, as two co-existing and co-definitive types of practice. Secondly, they reflect a key polarity from VCoP theory, the *synchronous*/*asynchronous* modes of participation (denoting the practice's rhythm), allowing for 'togetherness and separation across time and space', and enabling in this way, members to take control of their CoP-based learning (E. Wenger et al., 2009). Finally, they correspond to contemporary trends in HCI (and UCD) research that focus on the *affective aspects* of the interaction between *people* and *technology,* as well as *people* and other *people* in technology-supported environments (Hassenzahl, 2004; Heuer & Stein, 2019; Sanches et al., 2019).

10.2.2 Social Design Implications

The themes which frame the guidelines under this component focus on *participation*, *non-participation*, and *peripherality,* as well as *accountability*.

Agreeing with other authors (Booth & Kellogg, 2015; Johnston, 2016), these themes are inter-related to *power* and *socio-emotional* factors, like *trust.* As previously mentioned, power relations are bound to the *meaning-negotiation* processes in CoPs, and relate to the members' level of participation and identification with the practice.

In this work, power relations emerged in practice, not as a form of conflict, like Fox (2000b) describes them, but as *asymmetries* that may 'silence certain voices' at times, warranting special attention from CoP stewards. These power asymmetries were recorded in both '*learner-to-learner'* and '*learner-to-expert* 'contexts. It is worth clarifying that while external members (alumni mentors, industrial mentors, experts) are *local* or native stakeholders of the CoP, they are also considered as *global members,* due to their industry practice which inevitably requires them to participate in various other communities (i.e. business/industry affiliations, memberships in professional associations) (E. Wenger, 1998); that is, participation across a *Landscape of Practices* (LoPs). As such, we refer to these power relations as *local-to-global* and *local-to-local*, and discuss these in the following two sections.

10.2.2.1 Local-to-Global Power Relations

The management of power relations in the *local-global* CoP exchanges, from the global members' perspective, emerged as important in this study. This justified the need for guideline *SO2,* which aims to empower the external (global) members of the CoP with richer information as to their role and purpose in the practice. In this way they can form a better understanding of the *locality* of the practice, be it the academic processes, the teams involved, the divisions of labor, the roles and contributions, and the aspirations, limitations, and perceptions of learners in the practice. This finding is relatively new in literature, as most of the work on CoPs is dominated by the notion of empowering novices with legitimate access to expert knowledge, yet, the opposite has not been much considered, despite it being important. In this regard, our findings somewhat agree with Boylan's (2010) understanding of LPP as a concept, which claims that in effect all participation is *peripheral*, as expert members also take part in an ongoing process of learning, as they borrow from the fresh perspectives that learners bring into the practice.

It is thus critical that all information surrounding the *local* practice in cross-organizational CoPs is explicit to the *global* members, granting them – on the one hand – enough power to drive the meaning-negotiation processes, and allowing them – on the other – to observe and get new insights from novices (Consalvo et al., 2015; Probst & Borzillo, 2008).

Another key finding related to guideline *SO2* and receiving new attention as part of the cross-organizational context, concerns power in the form of *control*. Specifically, the transfer of authority over to the global members of the CoP (guidelines *EP8 – EP11*), based on their dominant role in *feedback* and *evaluation*, requires educators to 'lose' a certain degree of control in their learning environments. Allowing others to become key *epistemic agents* in the educational space can be challenging, and may present some 'unintentional' resistance (Stroupe, 2014). All the same, we claim that this empowerment is not boundless, as it can be proactively monitored to prevent possible risks to learning, such as those encountered and addressed by the guidelines in this work. They concern the coordination and moderation of feedback, in terms of its focus, tone, and volume, as guidelines *EP5 – EP7* recommend.

10.2.2.2 Local-to-Local Power Relations

This research has also unpacked issues related to the *local-to-local* (*learner-to-learner*, in specific) power relations in the CoP, that necessitate attention from stewards as per the aims of guideline *SO1*.

In this case, our outcomes differ from others' (Cundill et al., 2015; Fox, 2000b; Roberts, 2006) who discuss power asymmetries as an exclusive social characteristic of *canonical* communities, these being communities that are designed, coordinated, and often, financed by organizational management. Their claim is based on the premise that *organic* communities, built upon an inherent interest and allegiance to a joint enterprise, are not prone to such asymmetries. While it is true that managed CoPs may experience more intense power issues, findings from this work indicate that naturally-formed (organic) communities are not immune to such either. Organic CoPs in the educational sphere involve individuals with a different degree of *identification* and engagement with the practice, usually associated with different levels of competence and performance, concepts which entail power in themselves. Our findings correspond to those from similar studies who demonstrated a link between active community engagement and overall academic performance (Nistor & Fischer, 2012; Smith IV et al., 2020). Moreover, as these traits gradually become reified into *statuses* (i.e. knowledgeable, expert, proficient, specialist), they yield different levels of power over the negotiation of meaning in the community.

Design implications for this phenomena denote that such power asymmetries should be anticipated and mitigated for the benefit of learning. In fact, our findings coincide with Wenger's (2013) guidelines to "design for balance", since no learning occurs without power issues; and accepting this as not a necessarily bad outcome; in the absence of the 'powerful' who are active *meaning negotiators*, there would be no one to learn from, identify with and aspire to become like. The aim of CoP stewards in this case, is not to 'demolish' power, but to investigate how it may compromise other important voices that deserve to be heard in the community (guideline *SO1*).

Like other CoP research in educational and organizational settings, this study uncovered that the complex nature of power and its distribution, relies largely on the *trust* structures that are present in the CoP, particularly on the *local* (i.e. learner-to-learner) level (Aljuwaiber, 2016; Stroupe, 2014). It has therefore synthesized a set of targeted guidelines which aim to promote *trust* (*inter* and *intra-personal*), reduce *competition*, and help the *peripherality* of members evolve into fuller forms of participation. These advise the early *transparency* of work amongst peers (*SO3*), the assignment of *different client projects* to different teams (*SO4*), the formation of *mixed-competence* teams (*SO5*), and the enablement of *physical proximity* (*SO6*) to enhance *relational proximity*, and consequently boost online participation (Nilsson, 2019; Trust & Horrocks, 2017). These guidelines align well with recommendations from relevant CoP research. They particularly coincide with Pyrko et al.'s (2017) suggestion to grant members with opportunities "to see what others are doing", in aim of a 'thinking-together' community, facilitating what Williams (2018) called a 'cross-pollination' of the work through open dialogue, opinion-sharing and free expression (Chang et al., 2008). Guideline *SO6* also agrees with existing research that verifies how face-to-face experiences can help build social proximity and *trust*, and hence have a positive impact on team and CoP-wide collaborations (A. DeChambeau, 2017; Matzat, 2010).

As such, these recommendations are not new. Yet, this work has empirically validated them through the lens of CoPs, and has structured them into a taxonomy that is targeted at the specific components of governance (Set, Social, Epistemic). This constitutes their understanding and application more manageable by those who wish to adopt them in their learning interventions.

From a theoretical perspective, the recommendations ensure that important learning phenomena, as these are conceptualized by the CoP theory, have enough room for materializing through the enactment of the proposed model. Particularly, the recommendations which require early transparency (*SO3*), physical proximity (*SO6*), and mixed-competence team formation (*SO5*) seek to augment LPP in the community. That is, they aim to empower all members with enough *legitimacy* to experience and learn from the practices of peers in the community (Lave & Wenger, 1999b).

Aside of LPP, the guidelines also aim to safeguard and promote the flow of *boundary experiences* (see section 2.3.6), in the forms of *meaning* that 'spill over' from one practice to another. In itself, the cross-organizational model reflects a bundle of practices, due to its *global* members' participation in other practices too, as previously explained. To further leverage its value, guideline *SO4* (allocation of different clients and projects to different teams) builds additional opportunities for *cross-boundary* insights (E. Wenger, 2010b). These stem from the characteristics of the diverse stakeholders (i.e. clients, target-users etc.), their particular demands, and the practices, routines, and intellectual assets they bring along, as rich information that traverses the boundaries of teams, especially in collocated conditions.

While on the one hand the *cross-boundary* nature of a cross-organizational CoP is undisputable, its *locality*, as a bounded entity on the other hand, represents an important privilege of the practice (E. Wenger, 1998). The boundaries of a community whose members strongly identify with, and their primary interactions need to be *prioritized* and reminded of (*SO8*), to sustain *accountability* and coherence in the practice through the continuous support of the common enterprise, mutual engagement, and shared repertoire.

To further support these, and in line with Wenger's et al.'s (2002a) countermeasures for members' *disconnectedness*, guideline *SO7* recommends the recruitment of fewer community members in the CoP. Through this, it foresees and addresses both issues of *lack of accountability* and *fear of public exposure* (what Waycott et al. (2017) describe as the 'virtual panopticon'), which represent common threats to participation in CoPs (Probst & Borzillo, 2008). In addition, both guidelines *SO7* and *SO8* supplement the *SE5* guidelines (multi-role, multi-permission, modular visibility interface), in an aim to facilitate a flexible shift from the *local* – to facilitate the *bounded practice* - to the *global* - to facilitate the *cross-boundary practice*, and vice versa, depending on the emergent practice needs.

10.2.3 Epistemic Design Implications

10.2.3.1 Time

Guided by its central role in the foundational CoP theory, relevant research sought to understand the effects of *time* on participation, the co-evolution of knowledge and competence, the transformation of identity, as well as the respective *time strategies* that promote the effective realization of all of these (Cundill et al., 2015; Jackson, 2016).

Findings from this work strongly comply with Goodyear's & Caravalho's (2016) recommendations to treat the *pragmatic time issues* of networked learning as critical for its analysis. Time-related findings also address Amin & Roberts' (2008) call for *transparency* in the real phenomena and the targeted implications for particular genres of CoPs (i.e. in terms of their composition, size, epistemic field, purpose, and context). This work thus provides a special understanding and definition of specific CoP governance mechanisms relating to *time*, based on how *time* is interinfluenced with the epistemic activities of the cross-organizational CoP, due to the fact that: a) there is *synchronicity* between the local and global (academic and CoP-based/industry) activities, and b) *time* is often extremely limited for global CoP members due to their professional obligations.

Guidelines *EP1-4* designate *time's* inherent connection with the social and epistemic phenomena in CoPs and coincide with directions from related work. These directions advocate the early involvement of members in the *design* and *testing* of the epistemic ecology (*EP1-3*), falling closely with heuristics from Wenger et al.'s (2002a) design principles for VCoPs. They are also consistent with the ACAD framework recommendations for planning, specifically: a) the collective *needs analysis* and the planning of the 'chain of operations' that are likely to develop in practice, *before* the practice, and b) the creation of *visual representations* (versus relying on abstract concepts), to clarify the components and activities of complex epistemic ecologies for all stakeholders prior to the practice.

Like relevant research, this work also addresses the distinct differences between traditional instructional practices (i.e. lecture-driven) and CoP-based learning (Morton, 2012), by recommending a form of planned *synchronicity* between the two. Guideline *EP4* (curriculum should thematically and temporally coincide with CoP activities) is of critical value in the cross-organizational model, as it aims to deepen the meaning of learning, through a process which is – concurrently – *part-academic* and *part-pre-professional*. It agrees with Amin & Roberts (2008) who support the situating of '*knowing in action*', through concurrent academic instruction and practice with real-world problems and authentic projects. It also follows Hagstrom's (2006) directions on encouraging students to transform information (academically created) into practice-based knowledge (authentically practiced) in a *timely* and meaningful manner. All of these views agree with the objectives of the cross-organizational CoP model and are in full agreement with its proposed *time*-related guidelines.

10.2.3.2 Feedback as a Boundary Object

Additional guidelines falling under the *epistemic* component, although related – yet – are not exclusive to *time*. They rather concern the expert *feedback*, as a primary factor of social learning and collaboration, which is responsible for the epistemic 'aliveness' of the CoP (E. Wenger et al., 2002a). In fact, guideline *EP5* represents the backbone of the cross-organizational model, responding to Boud's & Falchikov's (2006) call for a "conceptualization of the place of assessment in learning beyond the academy", that is facilitated and diversified by the perspectives of various stakeholders, "including parties external to the educational institution".

The value of the cross-organizational epistemic design (and the respective findings), lies in the legitimate enablement of students to access a practice which is populated by different types and levels of expertise. As previously discussed, the non-academic members essentially transform the learning space into a Landscape of Practices (see section 2.3.6). From a LoPs perspective, LPP becomes more complex since it generates diverse learning opportunities requiring members to sustain cross-boundary connections with people of different backgrounds, perspectives, needs, and goals. Thus, the *feedback* that ensues, is often complex, in that it involves more intense *meaning-negotiation* processes. Guidelines *EP6* and *EP7* (proactive *moderation* of feedback, and encouragement of feedback *reciprocity*) aim to lessen the severity of such intensities, to leverage the feedback's full learning potential. However, they are only meant to exert a moderate amount of control over it (i.e. feedback tone, volume, focus) in order to sustain its *cross-boundary* merit. Agreeing with others (Novakovich et al., 2017), our findings inferred that 'breakdowns' and other emotional events, caused by the complex and varied feedback, often generate reflective learning episodes, better engagement in the practice, and higher epistemic attainments in the end. Complex feedback is therefore critical for students' professional evolution in becoming "reflective practitioners" (Jackson, 2016) who are able to manage similar challenges in their work lives. Such positive developments should thus not be disrupted but managed, aiming for a climate of moderate, but creative, tensions instead.

The *feedback* diversity and ensuing phenomena originate from the CoP's external contributors. Their role, input, and purpose in the cross-organizational CoP, should thus be clarified for both ends (learners, experts) of the *feedback* activity (as guidelines *EP5-EP7* do). This work's contribution in this respect is unique. Based on proven empirical findings from the model's enactment, it provides specific directions to benefit from the rich expertise that infiltrates the practice through the *feedback* process, in a meaningful - rather than - random manner.

10.2.3.3 Distant and Narrow Epistemic Proximities as Boundary Relationships

CoPs are largely homogenous entities, yet, cross-organizational CoPs bring certain heterogeneity to the practice (Fischer, 2001). The development of competence in a *local* practice which is entangled with many others (LoPs), and the crossing of epistemic boundaries is inevitable and necessary in the cross-organizational model. Afterall members need to build ways to communicate and understand the necessary information (familiar and foreign), in order to "get things done" (Pyrko et al., 2019). Likewise, the fact that such boundary 'cross-overs' were enacted in this research warrants that CoP stewards should anticipate and support them in the cross-organizational CoP. According to guidelines *EP8-11*, there are two types of *boundary* experiences, which derive from the level of proximity in practice: *distant* and *narrow proximity* experiences.

Primarily, the roles of industrial mentors (clients) who come from different backgrounds, are epistemically *distant* to all other roles in the Design-based CoP. As a result, they inevitably share 'boundary' information (i.e. rationale, culture, goals, methods) from the practices they belong to, and bring along a set of *reified* objects (labels, vocabulary, documents, formulas, expressions) that they use.

On the other hand, *narrow proximity* denotes a shorter *epistemic* distance (i.e. practitioners in the Design fields) and reflects the roles of *mentors* and *experts* in the CoP, although these also encompass some distance. Alumni mentors, for instance, are seen as more *proximal* to undergraduate students, in terms of *time* (as recent graduates), *as well as from a generational* and *relational* perspective, as opposed to industrial experts. This follows Wenger's (1998) concept about a community's learning benefits, with members of close *epistemic* proximity, being in similar age-groups, and having similar interests, and therefore requiring smaller leaps of effort to collaborate and learn together. By contrast industrial experts – though epistemically proximal - reside further away on the *generational* and *relational* axis, and may constitute more distant targets for the day-to-day practice of learners (E. Wenger et al., 2011). In effect, the experts' input in the practice is implicit, yet their long-term contribution and impact on learners' identities is fundamental, as this work confirms.

The *EP8-11* implications enact, corroborate and extend existing claims concerning the opportunities for learning in a cross-organizational CoP, as a LoP (see section 2.3.6), through a blend of *multi-generational* and *multi-relational* proximities, that facilitate different boundary encounters between their members (Culver & Bertram, 2017; Patahuddin & Logan, 2015). These allow learners to enter the three *modes of belonging,* which refer to *engagement, imagination and alignment*, in the following ways:

First, they help generate an understanding (*knowledgeability*) of the wider "geography of competence in the social world" (E. Wenger, 2013), as opposed to academic-only stimuli. Through their *engagement* in the practice, learners gain access to expert trajectories, as different journeys across this geography, which are highly relevant to those that learners will embark upon. It thus allows them to form a mental matrix of the different entangled practices, roles, and competences involved in their professional LoP, as well as the possible journeys one can take, helping them to gain a sense of their own purpose and orientation within this geography (E. Wenger-Trayner, 2016).

Next, they instigate a *modulation* of the learners' participation across the LoP, based on mechanisms of *imagination* (i.e. envisioning themselves as experts). In other words, through a filtering process, they are able to form and follow decisions concerning the practices they wish to progress in, and those they'd rather remain peripheral to, guided by their attained *sense of purpose.*

Third, they encourage learners to practically *align* with a primary practice of choice, by negotiating their own *claims to competence* in this, that either get accepted or rejected by others in the same practice. We observed this happening on a *local* context (i.e. in the technical SN posts), as well as a *global* context (i.e. counteracting the expert feedback with theoretical evidence and empirical suggestions) in this research. Each knowledge statement made in the practice (i.e. produced artifacts, new findings, suggested tools, resources) was in fact a *claim to competence,* which required members to provide evidence to support, negotiate and persuade others about. This is a process of *alignment* revealing a *negotiation of* the *identity*, in order to claim or enhance a legitimate position within a CoP.

The *EP8-11*guidelines are thus in full agreement with Jackson's (2016) work which focuses on the importance of complex CoPs, as *LoPs*, in the development of learners' *pre-professional identity* from the early university years. This starts from purely academic and evolves into its broader professional realization, through the rich boundary experiences gained in the CoP practice (Farnsworth et al., 2016; Novakovich et al., 2017).

10.3 Contributions to CoP Research

The contribution of this research is diverse and lies in its addressing various gaps that surfaced from the review of literature in the areas of *CoPs* and *creativity*, as Figure 33 and Figure 34 demonstrate. These are discussed in the following sections.

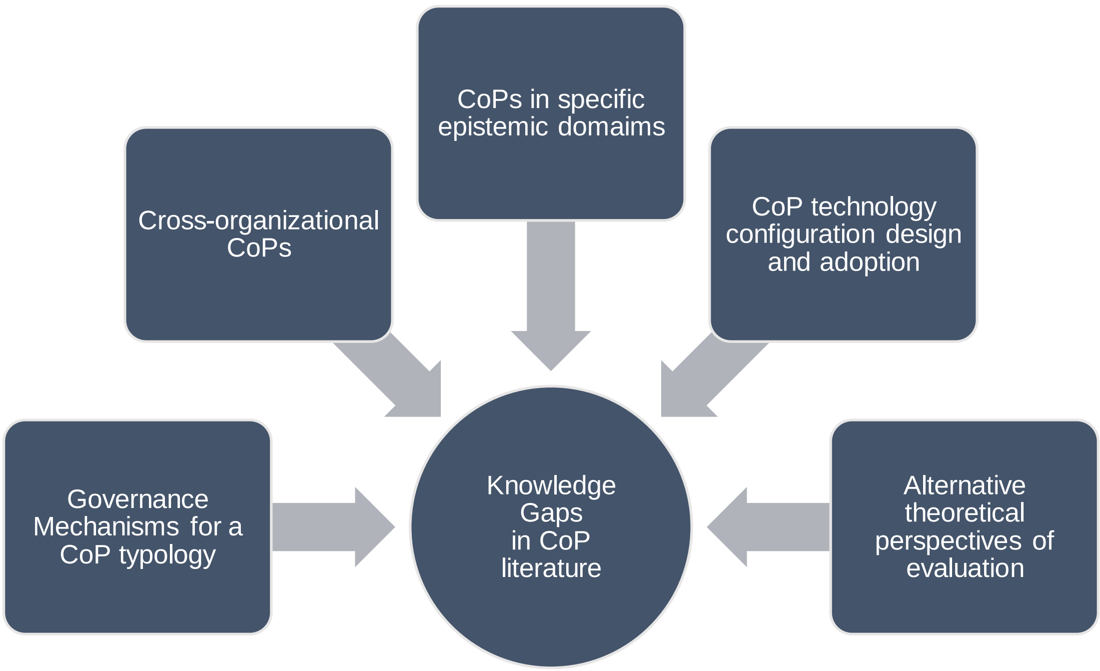


Figure 33: Key knowledge gaps in CoP literature

10.3.1 First-time Validation of the Cross-Organizational CoP model

There is a reported lack of research with a focus on industry-university collaborations (UIC) which aim to foster the development of the critical skills required by the industry today. Aside of such collaborations being largely research-focused (as opposed to education-focused), most of the existing UIC work follows conceptualizations from organization-based research to guide its design and evaluation (Albats, 2018; Etzkowitz & Ranga, 2015; Ivascu et al., 2016; Scandura, 2016). However, efforts that employ established and rigorous learning theories, such as CoPs, being “one of the most articulated and developed concepts within broad social theories of learning” (Lea et al., 2005), are still limited to non-existent. Specifically one of the few efforts addressing the concept of *cross-organizational* CoPs in HE, comes from the work of Jackson (2016) who proposed such a conceptualization, as an effective approach for the cultivation of *pre-professional* and *professional learner identities*, and consequently, the improvement of graduate employability.

The current work advanced this conceptualization into a validated CoP model, through its design and empirical enactment, as well as the evaluation of its impact on learning in HE. In effect, this dissertation provided a) rich descriptions of the cross-organizational model, drawing from foundational CoP and adjacent theoretical and empirical work, which is informed by the unique learning requirements that are inherent in the HE Design disciplines, and b) accurate accounts of the effective or challenging factors of its enactment, from the *technological*, *epistemic* and *social* perspectives. Based on its findings, this research has concluded with a collection of structured guidelines that are appropriate for similar CoP incentives in HE, as described in the next section.

We are aware that education-based CoP interventions are subject to their particular conditions and characteristics, which constitute each case unique. At the same time, the fact that our findings confirm those of others (across various examples of empirical work) even within seemingly different genres of CoPs, reinforces the *transferability* quality of the model (Borzillo, 2017; Novakovich et al., 2017; Waycott et al., 2017). This corroborates the significance of this first-time validation of the cross-organizational CoP model, which lies in its capacity not only to guide the design, but to also forecast and minimize likely risks, which may pose threats to CoP participation and social learning.

10.3.2 Governance Mechanisms for a CoP Typology

Current literature warrants targeted recommendations for CoPs of a specific *structure/scale*, *scope* and *purpose*, drawing upon the limitation of a ‘one-fits-all’ approach for their effective steering (Dubé et al., 2005; Hsu et al., 2007). This research responds to the critical need for the *classification* of different CoPs combined with appropriate *governance implications* for their effective design, administration and evaluation (Borzillo, 2017; Keay et al., 2014; Probst & Borzillo, 2008). It should be noted that most of the work on CoP governance evolves within professional - as opposed to educational settings, with no references to *cross-organizational* contexts. We therefore assert that the model offered in this research (see section 9.2 and Appendix I) can support similar CoP incentives in HE, with critical implications for the *design*, *enactment* and *evaluation* of CoPs.

10.3.3 CoPs Localized to Specific Epistemic Domains

The analysis of existing literature revealed a lack in research which identifies and clarifies the particular *epistemic* and *social* structures of CoPs, that are characteristic of certain educational disciplines, in order to support the entry and epistemic development of learners in their CoP practice (Amin & Roberts, 2008; U. Smith et al., 2017).

This research provides the necessary degree of specificity to address the *epistemic* activities that are inherent in the Design disciplines. Amongst others, these involve high levels of collaborative activity for the development of *creative*, *visual*, and *technical* artifacts. While these are discussed, as entangled with the technology that makes their enactment feasible (described in the next section), it should also be mentioned that this research has offered concrete evidence of the CoP's positive impact on the learners' epistemic and creative outcomes, drawing on significantly positive (quantitative and qualitative) results.

Additionally, the work emphasized the role of *feedback* as an inherent and critical factor of the epistemic activity in these disciplines. It responded to the calls for further research on promoting diverse Design-oriented *feedback* to enhance the learners' feedback literacy skills and thus, to prepare them for the realities of professional practice (Binkley et al., 2012; Carless & Boud, 2018; Loizides et al., 2019). It also highlighted the significance of enriching feedback with *authenticity*, as an important enhancement to traditional university-centered and instructor-only approaches. Finally, it also verified its feedback propositions through evidence of their positive capacity to enhance learning by: a) improving the learners' metacognitive and learning regulation skills, b) empowering them to pragmatically realize their position within the broader *geography of the professional practice*, and c) reconfiguring their learning goals through a process of 'grounding' or *alignment* with the global community in the Design domains.

The *epistemic* significance of the model proposed in this work thus lies in its capacity to: a) frame its findings into sets of effective as well as challenging epistemic issues that surface in Design-based CoP practice, to make them easily discernible by prospective CoP stewards, b) suggest practical interventions that aim to bring the academic and CoP-based activities together into an integrated ecology for Design studies, and c) propose methods to evaluate the outcomes of the enactment of this ecology (see Appendix I).

All of the above aim to empower prospective CoP researchers or practitioners with full clarity on how to adopt, steer and evaluate the cross-organizational model in other Design-oriented learning contexts.

10.3.4 CoP Technology Configuration Design and Adoption

Adopting pedagogical practices that link learning to the real-world practice, is a critical step for innovation. While existing work offers technology design and evaluation implications for CSCL/CSCW research and practice (Dillenbourg et al., 2009), the contribution of this work is specific for the following reasons.

First, it frames and supports its technological intervention based on the theoretical scope of CoPs. Second, it responds to the challenges of localizing technology to the particular needs of Design-based CoPs in HE, which largely involve *visual*, and *technical* (i.e. programming) co-activities. In this context, the specific practical guidelines offered in the model are crucial, as their purpose is to appropriate the learning space to these design co-activities, and thus enable learners to gain control of their learning and collaboration processes. Third, while the technological learning space facilitates local-to-local (university) interactions, it also becomes an opening to the outside world (industry - global) through its *cross-organizational* dimension; in doing so, it is subject to the inherent geographical, temporal, relational, or cultural disparities of the two spheres (Albats, 2018). This adds an additional layer of complexity to the design and steering of *technology*, so as to effectively accommodate the specific Design-based (local) activities on the one hand, while also addressing the different characteristics of its heterogeneous members (global), on the other.

Finally, a large amount of the technology configuration guidelines aim to address *affective* issues (i.e. power asymmetry/balance, trust, safety, competition) which bear impact on the socio-epistemic processes and outcomes. In doing so, this work aligns well with a new wave of research which places focus on the role and significance of affective factors in the HCI (Stephanidis et al., 2019). Specifically, this emphasis entails affective conditions that are characteristic of : a) the social conditions, as in the *human-to-human* collaborations for the design and development of creative outcomes, and b) the *technological* conditions, as in, the tools and workspaces that enable such creative collaborations to occur. This work is inherently linked to HCI, as an essential component of Design theory and practice (discussed in section 1.1).

In effect, the CoP model proposed in this dissertation factors these crucial considerations in; it provides distinctive technology configuration guidelines, which are attuned to the particular dynamics of Design-based communities of a cross-organizational scope, with an aim to mediate authenticity and foster creativity in the learning processes and outcomes.

10.3.5 Alternative Theoretical Perspectives of Evaluation

It has been observed that while CoPs have been widely adopted as a framework across research, educational, and organizational contexts, related studies have largely focused on theory verification (i.e. empirically identifying key characteristics of CoPs in various social formations) and emphasizing ‘over-researched’ theoretical dimensions (such as joint enterprise, mutual engagement, and shared repertoire), leaving other critical dimensions of CoPs unexplored (U. Smith et al., 2017). Our literature review pointed toward a few of these dimensions, namely the need to examine CoPs through the ‘Value Creation Framework’, for a thorough evaluation of their impact on learning, the important aspects of *time*, *power*, and *identity* in CoP participation, as well as the reconceptualization and investigations of more diverse forms of CoPs, such as cross-organizational Cops.

This work follows these directions closely, as it explores and contributes on the reconceptualization of CoPs, as *Landscapes of Practice* (LoPs), the role of *time,* and the *power relationships* that emerge in practice and influence learning, the key *dualities* that emerge as critical aspects of *balance* in practice, and how all these contribute to the transformation of learners' *identities* in reaching their professional potential and developing citizenship skills within a vast geography of related practices (Cundill et al., 2015; U. Smith et al., 2017). We briefly discuss two of the most critical ones amongst these, specifically, *identity* and *LoPs* in the following two sections.

10.3.5.1 Pre-Professional Identity Formation in a Cross-Organizational CoP

This work addresses the call for redefining the concept of 'graduate employability' to involve the development of learners' *pre-professional identity* while still in university (Jackson, 2016). In essence, all work-based interventions seek to indirectly achieve this; that is, to expand learning to include or merge the *academic* and *vocational* types of knowledge, and to cause a shift in learners' goals from merely academic, to the attainment of real-world skills and competence. We posit, however, that there is significant merit to the curriculum-integrated cross-organizational CoP, as opposed to other *work-based* approaches (i.e. internships) for learners' pre-professional identity development. First, the work-based approaches' most important limitation lies in that they are disconnected from the academic practice, leaving the *learning* process somewhat 'unmonitored'. Instead, the cross-organizational model attempts to mitigate likely issues of 'superficial' work-based approaches which fail to trigger *critical reflection* on behalf of learners (Marshall et al., 2014). It does so by offering a 'mentoring bridge' to the outside world, while parallelly allowing instructors to monitor the knowledge-creation processes that students engage in during CoP-based work, the ways in which they reflect upon them, and how they transfer these into their processes and outcomes (see EP4 guidelines).

Second, traditional work-based approaches rely on the premise that a substantial amount of learning precedes them. In contrast, the cross-organizational model provides *real-time linkages* between the curriculum-based and authentic work-based learning. In doing so it aims to offer learners a meaningful visit into the broader (global) practice, while relevant learning practices are concurrently happening in the curriculum. In this way, it substantiates the value of the academic practice through its *authentic* application, and provides a sense of the true experiences of designers in the professional practice, quite early on in education. In support of this, Jackson (2016) emphasizes that it is crucial for learners to start their ‘professional socialization’ process and develop citizenship skills early on in university.

Third, it aims to moderate the *steep* learning curve from the structured academic, to the unfamiliar and ‘messy’, work environments. This can be overwhelming for students who are forced to make enormous leaps of effort outside their normality (P. Brown, 2015). Instead, the *local* and *global* (academic-industry) interplay through the CoP can assist in pre-professional identity development with some ‘trade-offs’ in complexity, an approach that can be less harmful for learners (E. Wenger, 1998).

It should be clarified that the cross-organizational model does not claim superiority over (nor does it seek to replace) other professional development practices. Additionally, it doesn’t assert that learners can develop full knowledgeability of the multifaceted processes and challenges that come into play in the real profession. It rather aims to supplement and join other approaches towards a common goal. CoP interventions can for example precede work-placements, to help initiate the development of pre-professional identities and lessen the relational gap between university and work in advance.

10.3.5.2 Learning Through a Landscape of Practices (LoPs)

It is important to highlight this work’s alignment with more recent re-conceptualizations of CoPs in research, which involve Landscape of Practices (LoPs), as a way to foster and understand the richer learning phenomena that develop through an *entangled* set of practices (E. Wenger, 2014; E. Wenger-Trayner, 2016). As such the cross-organizational CoP model follows directions of going beyond the study of mostly homogenous CoPs (intra or inter-organizational), to more complex communities, which involve a membership from different spheres, as well as *adjacent* (sub) disciplines, to generate more authentic and robust opportunities for learning (Cundill et al., 2015; Pyrko et al., 2019).

It should be noted that this work contributes equally to the design and steering of *CoPs*, as *bounded* entities, and *LoPs*, as *diverse* groups, through the cross-organizational dimension. In other words, while it helps delineate the boundaries of its primary (bounded) practice (in terms of interests, expertise, outputs, goals, and activities), it also places learners within a landscape of interconnected practices (i.e. similar Design sub-disciplines), and assists them in developing *knowledgeability* of the different types of competence that exist in the broader spectrum of their intended profession (E. Wenger-Trayner, 2016).

While conceptualizations of LoPs can be found in various studies, the outcomes of their enactment and resultant design implications (i.e. as cross-organizational interventions in HE) remain under-investigated (Pyrko et al., 2019). The design for learning that necessitates the smooth integration of a heterogeneous membership into a shared practice, transforming the community into a LoPs, is both challenging and uncertain. It requires clear and actionable guidance to manage the human capital, the epistemic processes, and the technologically-supported learning space towards the objectives of this practice effectively. Hence, the cross-organizational model in this work makes an important contribution to CoP research in this aspect.

10.4 Contributions to Creativity Research

This work addresses three important gaps that have surfaced through the review of literature on creativity, denoting dearth of work on *distributed creativity*, particularly in its *technologically-supported* form, as well as the lack of self-reported *instruments* with validated psychometric properties, that aim to measure distributed creativity in natural learning settings (see Figure 34).

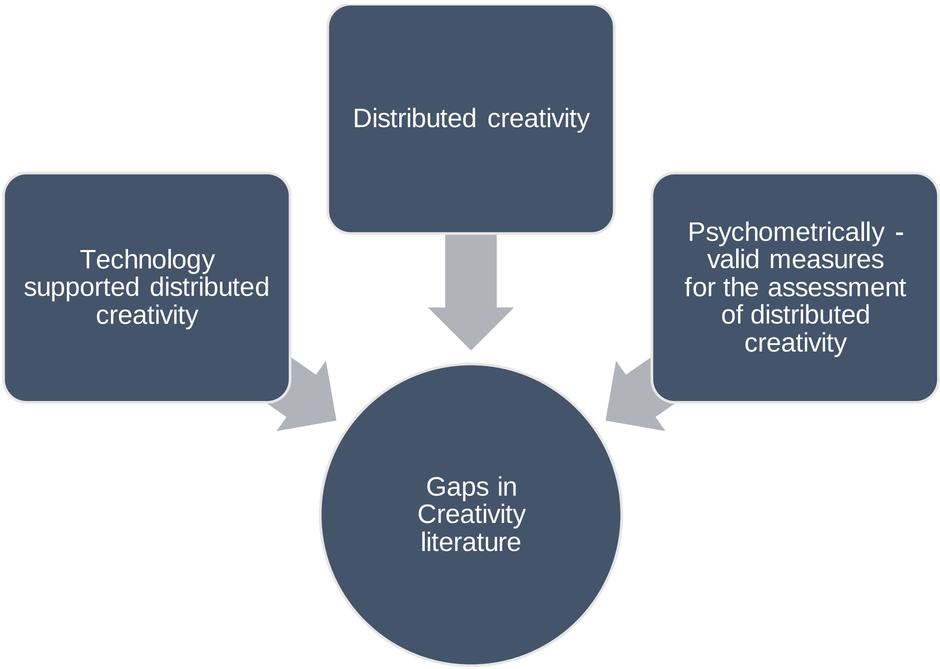


Figure 34: Key knowledge gaps in Creativity literature

We focus on this work's respective contribution to creativity research and start by jointly discussing the first two as they bear considerable overlap within the scope of this dissertation.

10.4.1 Technology-Supported Distributed Creativity

Recent directions in creativity research have emphasized the need for approaching creativity as a distributed phenomenon, taking into account the creative processes of teams, and exploring how these are shaped by the particular contexts they transpire in (Glăveanu, 2014). Likewise, from a socio-technical perspective, new HCI incentives attempt to examine the relationship between *humans*, *technology*, and *context* (physical / technological), with an aim to support the creative co-activities and outcomes of teams (Stephanidis et al., 2019). These new directions for creativity research are in full agreement with the objectives of our research and its underlying philosophy of social learning in CoPs, which is largely oriented toward promoting creativity.

We posit that the contribution of this work is significant in this regard, since it offers a new and empirically validated learning model, as the means to effectively design, foster and understand (or evaluate) *creativity*, through multiple approaches and perspectives. Specifically, it provides rich descriptions and practical guidance for the setup of a technologically-supported socio-epistemic ecology, that can facilitate the *creative collaboration* processes of its members. It then proposes ways to explore and measure these, drawing attention to the contextual factors that influence *creativity*, such as the *social* environment, the *technological* tools and materials used, the *roles* and divisions of labor, the *procedures* followed, the ways that these evolved over *time*, and the creative *outcomes* that resulted from these.

Importantly, this work also proposes that the evaluation of distributed creative phenomena is not restricted to summative approaches and single-assessor (i.e. instructor) perspectives only, but instead adopts a diversified degree of formative and summative *social judgment*, made feasible through the cross-organizational membership it involves (Hennessey, 2017). We argue that this constitutes a fundamental contribution of the cross-organizational CoP model, which brings innovation in education and aims to foster the development of *creative*, and other soft skills, holistically, taking into account the real situated conditions they transpire in.

10.4.2 Psychometrically-Valid Measures for Distributed creativity

The objectives of this work were partially driven by the call for reusable, self-reported or externally scoring measures that can be employed to extract information on dimensions of distributed creativity (Candy, 2013; Cherry & Latulipe, 2014). This research responded to this call by undertaking the validation of the psychometric properties of the ASCC, an instrument which measures the perceived *creative collaboration* of teams in blended or online learning settings.

Its contribution toward the research community, geared toward *creativity* incentives, lies in the fact that it constitutes a tool that has so far been absent from literature. Driven by the need to move from *task-oriented* to more *value-oriented* techniques, it therefore aims to provide researchers with the opportunity to have at their disposal valid and reliable scoring instruments, as fast and flexible tools that can measure distributed creativity in natural (i.e. classroom), rather than controlled (i.e. lab-based) settings (Candy, 2013; Cherry & Latulipe, 2014).

As this work is driven by a *situated* philosophy, it posits that these tools should be employed as part of a *systems approach* to creativity, with an aim to derive a more holistic understanding of the interconnected components of *creative* phenomena – that is - the *people*, the *processes,* and the *socio-technical contexts* they emerge in.

10.5 Limitations

This research may present limitations directly related to its quantitative inquiry. First, with regard to *external* validity, due to the small number of participants and the localized nature of its sample (i.e. sample of convenience), it is difficult to generalize the findings to the population of interest, that is, students in Design courses. Specifically, the sample involved students from a Design department in a public university, who were enrolled into two class groups, forming in this way the control and experimental groups for the studies.

That said, there is greater confidence in the findings' *ecological* validity (i.e. transferring to different settings within adjacent disciplines) in this case, since the testing occurred in a *natural* (classroom), versus a *controlled*, environment, the stimuli under investigation (i.e. websites, epistemic outcomes) were naturally-occurring and concrete - rather than abstract and arbitrary, and the participants' behavioral responses were arguably representative of the real world, since the score-based tools employed (i.e. scales, questionnaires) are typically used in real-life situations (Gouvier & Musso, 2014).

An additional limitation may concern the *subjectivity* and *credibility* issues that are often associated with qualitative methods, due to their lack of objective and replicable findings. Such issues may be partially rectified, by conducting and reporting on inter-rater agreement for instance, if applicable. This represents (what is known as) a 'small q' approach, which attempts to bridge the *qualitative-quantitative gap*, through consensus-coding and resulting reliability values (Braun et al., 2019). We have employed such a method, in the case of the analysis of CoP-based *feedback*, through the use of a dedicated coding scheme (see section 6.3.3).

Nevertheless, the rest of the open-ended data analysis in this work follows a purely relativist paradigm, which prioritizes the researcher's role and level of engagement in the research, and sees subjectivity in the observation judgements not only as valid, but necessary, in order to uncover representative findings (Braun & Clarke, 2013, p. 94). The experience of the researcher as the instructor in the intervention in this case, was the enabling factor behind the interpretation of data, through the understanding and capturing of ideas that lay 'beneath the surface.' It was therefore considered inappropriate to reduce the worth of the analysis by pursuing a high inter-rater agreement value, an approach which – in this case - was more likely to draw *semantic* (surface), rather than *latent* (deeper) observations. Instead, abiding to a situated orientation, this work considers the researcher's role and input as critical in the knowledge production processes of the analysis.

Aside of *credibility* issues, to enable our work's *transferability*, we provided extensive and rich descriptions of its research context regarding the CoP's *technological*, *epistemic* and *social* infrastructure, throughout the course of this dissertation. As the social dimension is considered definitive of the cross-organizational model, the participation incentives of the various external roles have been thoroughly addressed in section 3.2.7. The sum of these steps helps other researchers to transfer the model and explore its learning potential with different samples, and in diverse contexts.

10.6 Future Directions

This dissertation has empirically extracted a set of principles that aim to assist researchers and practitioners adopt CoPs of similar purpose, structure, and scope in other learning environments. Nonetheless, these guidelines do not represent a 'doctrine' for a flawless adoption of the *cross-organizational* model in the HE Design curricula. It is anticipated that the design and enactment of the *CoP ecology* is subject to specific known and unknown variables. These may be the particular conditions and norms of the *social* group who participate in the CoP, the *epistemic* objectives of the subject, the *contextual* settings and affordances (physical or technological), and the institutional/management policies that are at play, to name a few. CoP stewards should thus be systematic, proactive, and attentive to the particular pre-existing or 'run-time' phenomena, in case the proposed *ecology* design needs to be modified to appropriate the respective learning conditions. They should also ascertain that it facilitates the flexible 'run-time' adjustments (co-configurations) on behalf of all members (academic-industrial) during its enactment.

As such, there is much room for further enhancing this research's trustworthiness, particularly, in terms of the *dependability* and *transferability* criteria, through future adoption and reporting on the enactment of the cross-organizational model. Some relevant propositions are described below.

10.6.1 Incorporating Non-Academic Perspectives

Within the scope of this work, the role of cross-organizational CoPs on learning has only been examined from a *learner's* perspective. We nonetheless acknowledge the fact that a denser involvement of the external stakeholders, in both the design and analysis stages, can be more beneficial. As the call for cross-organizational bonds between industry and academia becomes more imperative for HE institutions, it is important that researchers also place emphasis on the *non-academic* perspectives, these being, the perceptions, goals, needs, limitations, and behaviors of the industrial stakeholders, as members of the CoP. Their accounts can inform findings with diverse insights to create a holistic understanding of a CoP's potential, so as to facilitate enhanced practices and produce better *value creation* opportunities for learning. We agree with Albats (2018) on this point, that researchers should construct and examine more robust *university-industry* models, by approaching them from a *multi-stakeholder* and *multi-level* analytical lens, to examine the intra-organizational, inter-organizational, and cross-organizational phenomena that shape learning.

There is thus much room – under the umbrella of education-oriented initiatives - for models which also aim to support the external (industrial) stakeholders, towards an effective practice which fulfills the learning and work goals of the entire membership of the CoP.

10.6.2 Adjacent Sub-disciplines

Various references were made throughout this dissertation, to the Design disciplines which subsume fields like architecture, engineering, computer science, and HCI, as these coincide in terms of their relevance, objectives, processes, methodologies and outcomes (Bhatnagar & Badke-Schaub, 2017; Zimmerman & Forlizzi, 2014). Although these areas share high levels of resemblance, further research is required within the learning environments of specific *sub-disciplines*, to validate and augment the cross-organizational model with more targeted information. It is important, for instance, to examine the inherent *visual* and *technical* interactions of participants in different sub-disciplines, and observe the benefits as well as the challenges faced in their specific day-to-day Design-related practices. Likewise, it also important to dive into each individual component of the CoP ecology (Set, Social, Epistemic) to explore the exchanges that take place within each one (intra), as well as the synergies between them (inter), and understand how these affect learning within particular subjects.

10.6.3 Diverse Cultural Groups

Aside of testing and validating the model within different Design sub-disciplines, this work invites further implementations of the cross-organizational CoP with members from either *inter or multidisciplinary*, and/or *cross-cultural* settings. While studies of CoPs with members from different disciplines, organizations and locations - within the same *sphere* (i.e. university-only) – exist, it is interesting to explore how the added *cross-organizational* attribute alters and molds the socio-technical, emotional, and learning phenomena that emerge as a result (Borzillo et al., 2011; Castañeda & Selwyn, 2018; Stone et al., 2017); like for instance, a CoP membership which comprises different sub-disciplines (i.e. Interactive Media, Business, Engineering), universities, and industrial stakeholders, as part of an international partnership.

There is a great need for understanding the multi-perspective learning co-creation processes within groups who are bound to face challenges “due to more substantial differences in personal background characteristics” (Dillenbourg et al., 2009), inherent across different disciplines and cultures.

10.6.4 Exclusive Online CoPs and the ‘New Normal’

Researchers and practitioners are encouraged to examine the cross organizational model within contexts that require *technology* as the sole enabler of a CoP’s practice, following the ‘new normal’ of the pandemic situation, as well as other types of circumstances which impede physical (community) presence. Driven by background knowledge on the differences in learning between *blended* and *online* communities, concerning important socio-epistemic and affective issues, such as *trust, power*, *governance* and *autonomy*, exclusive online cross-organizational CoPs thus warrant special attention to their investigation.

10.6.5 Putting Interoperability to the Test

Future studies are urged to explore the applicability of all Set (technology configuration) guidelines (see section 10.2.1), especially those who recommend *interoperability* between different purpose tools, such as generic productivity, social networking, and creativity support tools, with particular attention to the scope of the sub-discipline in which the CoP is enacted.

11 Conclusion

This dissertation presented the three phases of this research, namely the *Design & Implementation*, *Evaluation,* and *Integration* phases. Through these, the work provided a full account of the proposed CoP's ecology design, enactment and evaluation, from its *social*, *epistemic* and *technology* perspectives. Following this, it also extracted a set of practical *guidelines*, offering in this way an affordable and transferable *cross-organizational CoP model* to assist instructors, technologists, researchers, or practitioners who wish to adopt the model to enhance learning environments in Higher Education.

A total of six individual studies were conducted in this work to address the research objectives of each phase. Specifically, phase **1** informed about the design, enactment and evaluation of the technology configuration, the epistemic setup, and the social structure of the cross-organizational CoP, which was appropriated to the needs of HE Design studies. This phase also reported on the validation of the psychometric properties of a scoring instrument which was employed to measure the learners' perceptions of their team-based *creative collaboration* processes.

Phase **2** drew from the findings of phase **1**, combined with newly collected data, to evaluate the overall impact of participation in a cross-organizational CoP on the *learning value* and the development of learners' *pre-professional identities*, using the Value Creation framework.

Finally, phase **3** extracted *implications* for the design, implementation, facilitation, and evaluation of cross-organizational CoPs in the HE Design studies through a validated model, which incorporates bibliographic evidence, proposed instructional interventions, and appropriate evaluation methods, to assist in the integration of the model in other learning environments.

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Appendix I

Comprehensive cross-organizational CoP model: thematic findings, guidelines, bibliographic evidence, intervention examples, and evaluation methods for cross-organizational CoPs in Design studies

Table 52: Set component comprehensive guidelines

Findings (themes)		Design Guidelines	Agreement/disagreement with bibliography	Practical intervention examples	Evaluation
			SET		
WDD process model Digital CoPs Framework	**SE1**	Integrate member-preferred social networks (SN), field-specific creativity-support tools (CSTs), generic productivity, and online showcasing tools in the CoP technology configuration	• Technology configuration design framework (E. Wenger et al., 2009) • Identify effective design principles for digital platforms supporting online communities (Spagnoletti et al., 2015) • Attention to sociotechnical design problems & solutions (De Moor, 2015) • Technical & visual design communication tools (L. Dym et al., 2005) • Social media as the means to increase member communication & connection (Chou & Frank, 2018)	• Choose an all-encompassing platform to serve at the baseline of the CoP or - given the availability of technical expertise - combine & integrate different tools through trusted APIs to accommodate all practice needs of the community Suggested software[4]: Tribe, Exoplatform, Hivebrite, Samepage, Zoho, Wordpress	N/A
		Technical & Design-oriented communication: practical & socio-emotional considerations			
Resistance Usability issues Power asymmetries	**SE2**	Integrate effective technical Q&A interface capabilities like code-snippet sharing, execution, & debugging,	• Resistive agency (Novakovich et al., 2017)	• Integrate open-source Q&A platforms with technical communication interface capabilities, as the ones in:	• Quantitative data: scores & analytics for posts, replies, technical resolves, shares, likes,

[4] *All software tools URLS are listed in appendix II

		within the social CoP platform	• Effective technical Q&A models (Mamykina et al., 2011; D. Yang et al., 2016)	Askbot, question2answer, Stack Overflow • Alternatively aim for proprietary solutions like: Stack-Overflow "Teams" knowledgebase, or Piazza	stars (peer voting), resulting statuses (i.e. expert, junior expert/geek, super geek etc.)
Lack of identification Power asymmetries	**SE3**	Integrate automatic or manual gamification features in the social CoP platform to promote student interest & engagement in the practice	• High versus normal-to-low-competence participation & contribution in CoPs (Roberts, 2006; Sommet et al., 2015; Waycott et al., 2017) • Lack of identification (Probst & Borzillo, 2008) • Disparities of competence as power (Cundill et al., 2015; Farnsworth et al., 2016; E. Wenger, 2010c)	• Motivate members to follow up with online/offline community-driven activities & perform certain actions: i.e. set challenges, steer debates, collect marks for key actions like post, reply, like, stars, & share through analytics • Summarize analytics in score-boards • Derive member statuses based on that (i.e. expert, junior expert/geek, super geek etc.)	
Findings (themes)		Design Guidelines	Agreement/disagreement with bibliography	Practical intervention examples	Evaluation
Lack of technical writing skills Power asymmetries	**SE4**	Guide learners to make use of appropriate language for effective technical communication	• Barriers in technical Q&A language, community member marginalization (Frith, 2014; Mamykina et al., 2011; Smith IV et al., 2020) • Development of professional social media skills (Novakovich et al., 2017)	• Introduce quick class-based exercises which expect student teams to form technical or generic-type queries to get help from others and resolve them. Student teams can present their queries to the class • The instructor or facilitator can deliver quick lectures or provide learning resources for the development of technical & generic communication skills • Peers can evaluate these based on a) their compliance with heuristics, b) their overall communicative ability • They can then provide suggestions for improvement	• Peer & instructor assessment and reviews of students' technical posts • Instructor assessment of students' reviews of their peers' technical posts
Practical (usability) issues	**SE5**	Support modular visibility to accommodate various ad-hoc CoP interactions,	• Private & Public modes of participation (Gaillard & Rajic, 2014; E. Wenger et al., 2002a)	• Introduce visual collaboration software (i.e. Conceptboard, Groupboard) which allow easy integration with external	• Review of local-to-local, local-to-global CoP activity through:

Socio-emotional issues Power asymmetries Vulnerability Criticism Competition	 SE5.1 SE5.2	both from the initiator & the target member perspectives Provide on-demand activity-driven permissions Provide on-demand role-specific permissions	• Polarities: a) rhythms: togetherness & separation, b) interactions: participation & reification), c) identities: individual & group (E. Wenger et al., 2009) • Private versus public access (Khalid & Strange, 2016) • Virtual panopticon, lack of authorial identity (Brass & Mecoli, 2011; Dennen, 2016; Waycott et al., 2017) • Criticism (Baek & Barab, 2005) • Unhelpful comparisons' (Crossouard & Pryor, 2008) • Workspace awareness, multi-role permission, multi-channel communication, technology vs face-to-face communication, affective concerns in HCI (Dillenbourg et al., 2009; Gutwin et al., 1996; Hassenzahl, 2004; Heuer & Stein, 2019; Sanches et al., 2019; Spagnoletti et al., 2015; Stephanidis et al., 2019; Suthers & Hundhausen, 2003) • Visual & navigational discontinuity (E. Wenger et al., 2009)	tools that the community uses daily (i.e. document management, project management, communication, wikis, video conferencing & social networking tools) • These should provide public, semi-private or private community interactions Suggested software: Tribe, eXo Platform, Samepage, Zoho, Wordpress, Stack Overflow "Teams" KB, Askbot, Question2answer, Conceptboard, Groupboard, Openboard, Figma, Google Drive, OneDrive, Dropbox, Skype, Zoom, GoToMeeting, Confluence, Slack, Trello, Infolio, Open Project	• Software log / history for both initiator & responder efforts • Emails, chat activity, video-conferencing sessions, number of artifacts created / modified in shared space, time-on-task, visitation frequency, activity duration • Use of AI tools to monitor & analyze collaborative workflows: text analytics to generate quantitative results & qualitative insights on students' understanding, reasoning, & knowledge or collaborative gaps
		Visual design-oriented interactions			
Lack of authorial ownership Lack of workspace awareness	SE6	Aim to enhance workspace awareness in terms of peers' identity, position & activity in visual CST workspaces		If the tool's interface does not natively support workspace awareness clues (i.e. animated peer cursors, labels, modularized visibility modes), members could for instance manually: • use color-coding (i.e. background-color an area or canvas, or use color framing around visual artifacts) • employ specific icons and labels to signify a 'state-of-edit' & the author's identity	
Attention disruption Disorientation	SE7	Integrate various channels for multimodal communication in visual CST workspaces		The SE5 intervention examples are also applicable here (SE7)	

		Interoperability		
Difficulty in handling multiple different tools	**SE8**	Enable interoperability between CSTs, generic productivity, SNs, & other tools included in the CoP's technology configuration	• Integration through functional interoperability & data portability in agreement with current movements (Cyphers & O'brien, n.d.; ICO, n.d.; MIT, n.d.; W3C, 2017; E. Wenger et al., 2009) • Interoperability is not a 'technological quick fix" (De Moor, 2015) • Avoid practice intangibility (Probst & Borzillo, 2008)	Employ technical expertise (i.e. IT staff) to build on existing platforms' interface provisions to enhance functionality & enable data portability through Application Programming Interfaces (APIs). These are interfaces that allow developers to interact with another software or a service

Table 53: Social component comprehensive guidelines

Findings (themes)		Design Guidelines	Agreement/disagreement with bibliography	Practical intervention examples	Evaluation
			SOCIAL		
		Power relations: trust, competition & accountability			
Local-to-local power asymmetries Mistrust, competition Strong core group Strong one-to-one relationships Local-to-global power asymmetries	**SO1** **SO2**	Aim for even distribution of power through the balance of trust, competition & accountability in the CoP Empower external CoP members with compound and in-depth information on their purpose and role, as well as the other members in the practice	• Power imbalances are characteristic of canonical, financed & managed CoPs (Cundill et al., 2015; Fox, 2000b; Roberts, 2006) • Active behavior originates from individuals who are empowered, who feel that they are able to enact change and influence others (Broom, 2015) • Social learning-based theorization of power (Farnsworth et al., 2016) • Cognitive authority & power (Addelson, 1983) • Power as knowledge & competence (Aljuwaiber, 2016; Booth & Kellogg, 2015; Stroupe, 2014) • Strong core group of participation – peripheral majority (E. Wenger et al., 2002a) • All participation is peripheral (Boylan, 2010)	• (SO1) Generic guideline covering guidelines SO3-SO8 (see below) • (SO2) Prepare & share with external CoP members: documentation that includes a detailed account of projects & collaborative activities between students & them. Some of these documents may also be the students' responsibility to produce: • full project briefs, requirements, expected deliverable deadlines, & academic outcomes (based on lesson plan) (students' responsibility), • specific feedback foci (i.e. visual, technical, aesthetic, or other aspects of work) (instructor's responsibility), • practical information (i.e. word range/limit, feedback contributors per deliverable, suggested communication frequencies, tools) (students' responsibility), • contextual information (i.e. team structure & the individual roles & responsibilities of team members) (students' responsibility)	• Instructor review & evaluation of student-generated documents (referred to in SO2 intervention on the left) in terms of timekeeping, information accuracy, clarity, sufficiency, coherence, & communicative capability.
		Interpersonal (peer trust)			
Peripherality	**SO3**	Schedule regular work crits with students for constructive	• Avoid dishonest intentions (Chang et al., 2008) • Brokering (E. Wenger, 1998)	• (SO3) Organize systematic class-based (preferably) crits on the teams' deliverables, based on - for instance - a biweekly plan or on the scheduled deliverables	• Integrate a) interim student team presentations, b) peer critique & reviews into the

Lack of identification Mistrust, competition Rich boundary ‘spill-overs’	SO4	peer reviews, commencing early on in the project cycle Assign different industry projects & clients to different CoP teams, ensuring that they require same-level subject knowledge, creative adeptness & technical competence	• Cross-pollination” of work (Williams, 2018) • Develop open dialogue (Chang et al., 2008) • Make student-thinking public, provide scaffolding, confront misconceptions, enhance metacognition, encourage technically-sound assessment (Binkley et al., 2012) • ‘Thinking together’ (Pyrko et al., 2017) • Cross-boundary insights & prospects for learning (E. Wenger, 2010c) • Sharing of opinions & free expression (Macià & García, 2016)	• The rest of the teams should be called to contribute their structured feedback - either in verbal or in written form • (SO4) Whether institute-coordinated (i.e. strategic industry-exchange scheme) or faculty-driven, this initiative should aim for the timely (i.e. 30-days in advance) search and agreement for different industrial partners & projects, as the academic assignments for student teams • Aim to recruit local businesses, start-ups, non-profit organizations etc. • Normalize project brief requirements & outcomes across teams, guided by the course’s academic objectives	academic formative assessment plan, c) instructor assessments of the sum of peer reviews produced at the end of the semester • Set clear and equal assessment criteria with respective grades across all team projects
Findings (themes)		Design Guidelines	Agreement/disagreement with bibliography	Practical intervention examples	Evaluation
		Intrapersonal trust (self-efficacy)			
Lack of interpersonal trust (mistrust) Lack of intrapersonal trust (self-efficacy) More face-to-face interactions Contributive collective intentions	SO5 SO6	Aim for mixed-competence teams to form the CoP’s working subgroups Aim for community-wide face-to-face interaction early on & throughout the life of the CoP in order to boost online participation	• Vicarious experiences may undermine teamwork (Alberola et al., 2016; Bandura et al., 1999) • One-sided (high/low) accumulation of competence (Rubin, 2003) • Creating diverse teams, valuing inclusion & collaboration, empowering lower-attainment students (Boaler, 2006; Pociask et al., 2017; Tereshchenko et al., 2019) • Personality-type measures (Shen et al., 2007) • Physical proximity enhances trust (Aljuwaiber, 2016; Booth & Kellogg, 2015; Nilsson, 2019) • Face-to-face learning activities are critical elements (Trust & Horrocks, 2017) • Brokering (E. Wenger, 1998)	• (SO5) Team compositions should reflect an equal distribution of members' competence & other factors such as interests, skills, previous performance, personality, group-work attitudes, learning styles, prior work experience. • (SO6) Aim to organize at least one community-wide introductory meeting, at the start of the module/course • Various members can provide brief talks on their educational background, experience, work, & role in the CoP. • Follow up with regular events throughout the course, whenever the academic schedule allows for hosting invited experts for more in-depth talks, short workshops, or on-location visits to their work practice (where feasible). • Ensure that reified forms of this knowledge (i.e. public profiles, work portfolios, recorded talks	• Possibly employ the use of AI tools for team formation or other personality/psychological typing tools (i.e. Myers-Briggs Type Indicator (MBTI)) • Instructor observation and evaluation of student participation in expert-driven discussions • Integrate students’ outcomes (i.e. collective processes & resulting artifacts) from expert workshop sessions, in the

				& discussions, workshop sessions) are stored & easily accessed by CoP members.	(formative) assessment plan

Findings (themes)		Design Guidelines	Links to bibliography	Practical intervention examples	Evaluation
		Accountability			
Public exposure Lack of accountability in the CoP’s SN platform Forgetting or overlooking the purpose & actionable obligations	**SO7** **SO8**	Limit the size of the CoP to balance member accountability Highlight the intended responsibilities of each CoP role at the start & regularly throughout the life of the CoP	• Accountability equates degrees of competence, power & trust, engagement in blended CoPs (Nilsson, 2019; Roberts, 2006; E. Wenger, 1998) • Virtual panopticon, lack of authorial identity (Brass & Mecoli, 2011; Dennen, 2016; Waycott et al., 2017) • Criticism (Baek & Barab, 2005) • Unhelpful comparisons’ (Crossouard & Pryor, 2008) • Clear objectives provide members with responsibilities & motivate them to contribute more actively (Borzillo, 2017)	• (SO7) Academic membership: aim for a CoP structure which includes the students of the module/course, the instructor(s), & floating facilitator(s) (where applicable). • Industrial membership: use a ratio of 1 or 2 externals-per-student-team (i.e. alumni & expert mentors), to manage - but not overwhelm both ends with - the feedback & evaluation workload. • (SO8) Prepare a *systematic schedule* (table) of the members’ routine tasks for complying with & evaluating important project milestones (i.e. project deliverables) • If this table becomes too lengthy & confusing: ○ provide an initial simplified summary for students & external stakeholders alike ○ Then split this into the individual phases of the project cycle (and semester) & provide more detailed information for each one ○ Hand this to the CoP members at appropriate timings, i.e. at the end of each milestone and beginning of the next one (progressive disclosure)	• Informal team-based or individual (one-to-one) observation and evaluation meetings as part of formative academic assessment • Peer reviews (marks & comments) of teammates’ contribution at predefined project milestones

Table 54: Epistemic component comprehensive guidelines

Findings (themes)		Design Guidelines	Links to bibliography	Practical intervention examples	Evaluation
			EPISTEMIC		
		Time			
Time-based disparities between internal & external CoP members	**EP1**	Invite community-wide participation for the design of the learning ecology prior to its enactment	• Research to identify the specific epistemic structures to be orchestrated, so as to facilitate learning. Also, strategic time-management for the effective functioning of CoPs (Cundill et al., 2015; S. Smith & Smith, 2017; Spagnoletti et al., 2015) • Base learning design on collective experiences (E. Wenger et al., 2002a) • ACAD: employ collective analysis of needs & planning of the ‘chain of operations’, use visualizations versus abstract generalizations (P. Goodyear & Carvalho, 2016) • Identify & moderate disparities between CoP-driven & traditional academic practices (Morton, 2012) • Codified knowledge (through academic study) vs tacit knowledge (through ‘learning by doing’) (Amin & Roberts, 2008) • Focus on ‘how’ students transform information into usable knowledge (Hagstrom, 2006)	• (EP1) Collect & analyze the needs, limitations & suggestions of various CoP stakeholders via online/offline questionnaires, group meetings, interviews & informal discussions prior to the enactment of CoP-based learning activities. • Run participatory design sessions with representatives of each member role, to derive suggestions & best practices for the CoP’s epistemic design	• Integrate the initial contribution of students’ reporting of their needs, suggestions, diagrams & participatory design outcomes in the (formative) academic assessment plan • Repeat the above with students’ engagement in and activity levels during the piloting period
Need for timely and collective planning, guided by visual diagrams, & ample piloting time	**EP2**	Introduce visual representations to simplify the epistemic design and clarify its practical implications early on in the life of the CoP		• (EP2) Use sketching & diagramming methods to help brainstorm & clarify the ‘mechanics’ of the epistemic design ○ Diagramming & Mindmapping software: Lucid Chart, Greatly, Coggle, Miro, MindMaster	
Meaningful learning due to synchronized curriculum & CoP-based activities	**EP3**	Allow for sufficient time to pilot-test the epistemic design prior to the commencement of critical CoP-based learning practices		• (EP3) Allocate a period of time for faculty, students, & external members, to communicate & coordinate the ‘ways of working’ (public / private, synchronous /asynchronous) prior to CoP-based learning	
	EP4	Plan the academic curriculum to coincide – thematically & temporally - with CoP-based activities		• (EP4) Plan the syllabus & class-based activities (i.e. exercises) to thematically coincide with (or precede) the scheduled cop-based outputs (i.e. project deliverables	

Findings (themes)	Design Guidelines	Links to bibliography	Practical intervention examples	Evaluation
			for mentors, interim industrial presentations etc.) • At certain thematic units in the syllabus, ask students in class to discuss the CoP-related project issues they encountered (i.e. the technical feedback, or new client requests that relate to the specific unit), in order to resolve them with the help of peers, or reflect on the teams' counteractions collectively.	
	Feedback			
Positive outcomes from external formative assessment Non reciprocal student behavior in feedback processes Intense negotiations of meaning, reflective & self-regulatory episodes, tension in feedback processing, grounding	**EP5** Aim for regular feedback & evaluation of student work from expert CoP members to enrich the academic feedback process **EP6** Proactively negotiate the focus, amount & tone of feedback with external CoP members **EP7** Articulate comments appropriately to encourage reciprocal feedback activity in CoP-wide settings	• Focus on the role, effectiveness and challenges of feedback in ongoing learning in using feedback productively (Carless & Boud, 2018) • Need for a conceptualization of assessment in learning beyond the academy (Boud & Falchikov, 2006) • Challenge in preparing students for the feedback mechanisms they will encounter in the workplace (Loizides et al., 2019) • Avoid risks of single-path assessment approaches (M. Smith et al., 2005) • Support 'aliveness' in the practice (E. Wenger et al., 2002a) • Reflective episodes & better commitment to practice, following emotional events (C. Maxwell & Aggleton, 2014)	• (EP5) Following the outputs of guidelines EP1-EP4, disseminate the epistemic plan to CoP members. • Include a schedule of deliverables which clearly states the expected feedback contribution by specific CoP members i.e. '*Week 4: Low-fidelity prototypes submission & feedback by alumni mentors within a week'* • (EP6) Provide directions & discuss the feedback criteria with the external reviewers, in terms of: ○ <u>Focus</u> of specific deliverables i.e.: *'Week 4 feedback should focus on UI design & usability features, while in week 6, the focus of feedback shifts to system functionality'*	• Include the external stakeholders' evaluations, i.e. the graded project deliverables into the (formative) academic assessment plan • • Integrate these with instructor evaluations, as well as other formatively assessed academic deliverables (i.e. peer reviews) • Use questionnaires to extract student evaluations on the feedback's *focus*, *volume* & *tone* properties, as well as the opportunities for reciprocity provided by

			• Tension & conflicts are critical in becoming “reflective practitioners” (Jackson, 2016)	○ <u>Volume:</u> set a word-range, or a specific number of reviewers for each deliverable, for each team i.e.: *‘Assign one alumni mentor per team (versus all 3) to provide feedback on a specific week & limit this feedback to a maximum of 200 words per team’* ○ Alternatively, ask mentors to provide generic public feedback, based on everybody’s work (versus a one-on-one approach) ○ <u>Tone:</u> request to avoid plain judgements & harsh criticism, and instead use mild tones, constructive comments, & recommendations • (EP7) Request reviewers to invite student responses on process-oriented feedback; i.e. reviewers should ask questions & clarifications on the design processes, quickly brainstorm (i.e. in sync/async tools) with students on design possibilities, & compare their outcomes with others’ work (in the CoP) to generate feedback discussion ○ Mindmapping software: Coggle, Miro, MindMaster	the CoP experts, following every feedback milestone

Findings (themes)		Design Guidelines	Links to bibliography	Practical intervention examples	Evaluation
		The purpose of expert CoP members			
Identification with experts’ trajectories	**EP8**	Invite industry members with various degrees of expertise to provide briefs,	• Need for cross-boundary communication to ‘get things done’ (Pyrko et al., 2019)	• (EP8) For the role of industrial mentors (clients), seek to recruit local businesses, start-ups, & non-profit organizations in	• Include the external stakeholders’

		expert insights, feedback, & evaluation of student work	• CoPs require smaller leaps of learning efforts on behalf of novices (E. Wenger, 2014)	various sectors to provide projects, resources & regular feedback on project work. <u>Incentives for external members:</u> to receive assistance in the development of early ideas, as 'proof-of-concepts', or for projects that are pending, due to lack of budget, time, & human capital. • For the role of *industrial experts*, seek to recruit people with a minimum of six years expertise in the field, and/or in key organizational positions, coming from similar academic/industrial backgrounds. <u>Incentives:</u> opportunities to establish communication channels with universities, provide directions, influence outcomes, & have the chance to draw from a graduate talent pool based on their prior collaboration	graded project outputs into the (summative) academic assessment plan • Integrate these with instructor evaluations, as well as evaluations from other summative academic deliverables (i.e. exams) • Peer-team evaluations of projects • Evaluate students' reflective memos of their project performance & outcomes • Evaluate students' reflective memos of their experiences from the expert sessions (i.e. talks and workshops
Need for collocated interaction	**EP9**	Recruit recent graduates for the role of alumni mentors in the CoP	• Construction of professional identities (Woods et al., 2016) • Generational discontinuities (E. Wenger, 1998)	• (EP9) Alumni mentors should be fairly recent graduates with similar academic backgrounds to those of students <u>Incentives:</u> maintain social ties with the university, gather experience, enrich résumés, establish collaboration	
Identity transformation & grounding	**EP10**	Aim for sharing expert trajectories & 'inside' information about the industrial practice	• Understanding of the wider "geography of competence in the social world", development of identity through three 'modes of belonging'(Jackson, 2016; E. Wenger, 1998, 2013)	• (EP10) Invite experts to talk about their academic & professional career paths: university-to-industry transition, the evolution of their work & professional identity, various case-studies, challenging situations & counter-actions, views on the local/global industry, future career prospects, share useful online resources	
	EP11	Always include real industry clients & authentic projects to guide the CoP-based activities	• Multi-generational & multi-relational proximity (Culver & Bertram, 2017; Patahuddin & Logan, 2015) • Paradigmatic trajectories (E. Wenger, 1998) • The significant role of alumni for mentoring students in higher education (A. Rourke & Mendelssohn, 2017)	• (EP11) See EP8. Additionally, ensure that 'clients' are aware that project deliverables	

	will come in the form of ‘proof-of-concepts’ rather than ready-to-publish outcomes

Appendix II

Free or affordable technologies for CoP support

Community & Content Management Systems Software

Tribe: https://tribe.so

eXo Platform: https://www.exoplatform.com

Hivebrite: https://hivebrite.com

Samepage: https://www.samepage.io

Zoho: https://www.zoho.com

Wordpress: https://wordpress.org

Question & Answer tools

Stack Overflow "Teams" KB: https://stackoverflow.com/teams

Askbot: https://askbot.org

Piazza: https://piazza.com/

Question2answer: https://www.question2answer.org/qa

Collaborative Creativity support software

Conceptboard: https://conceptboard.com

Groupboard: http://www.groupboard.com/products/index.shtml (for designers and architects)

Openboard: http://openboard.ch

Figma: http://www.figma.com

Generic Productivity & Storage Software

Google Drive: http://drive.google.com

OneDrive: http://onedrive.live.com

Dropbox: http://www.dropbox.com

Live Communication Software

Skype: http://www.skype.com

Zoom: http://zoom.us

GoToMeeting: www.gotomeeting.com

Project Management Software

Confluence: http://www.atlassian.com/software/confluence

Trello: http://trello.com

Infolio: http://www.infolio.co

Open Project: http://www.openproject.org

Mind-mapping & charting software

Lucid Chart: https://www.lucidchart.com

Greatly: https://creately.com

Coggle: https://coggle.it

Miro: https://miro.com

MindMaster: https://www.edrawsoft.com/mindmaster

Appendix III

Focus Group Protocol sample based on the three-pillar set of questions (semester1)

Focus Group # /Date/

Team Number: ___________, Names: ______________

Thank you for your participation in this focus group. We welcome your experiences as well as views, ideas and opinions on learning through a curriculum-integrated Community of Practice in Design studies. Specifically, this refers to co-participation in the CoP with your peers, faculty members, alumni mentors, industrial mentors (clients) and industrial experts, for the communication and collaboration on real-life projects and other learning events.

Please note the following:

1. **What you say is confidential**. Although this session is audio-recorded, your responses are confidential and anonymous (in the report).

2. **Feel free to talk about anything you wish**. Even though I have prepared questions for you, you are allowed to talk about relevant topics if you feel something needs to be mentioned. I encourage everyone to participate – but please allow your peers to finish talking first (one at a time) please.

3. **There are no right or wrong responses**. Every person's experiences and

opinions are important, but please feel free to agree or disagree and support this with arguments.

4. **Flexibility**. You can choose not to participate, without any impact on your academic evaluation. Your stay assumes your agreement to participate.

The focus group session will take approximately 30 minutes.

Set

1. Which tools were most efficient, in terms of effective communication and collaboration for your a) team-based, b) group-wide (i.e. classroom-based) or c) community-wide processes? (Conceptboard, Beehance, Google Drive, Moodle, Hypothes.is, Email, Hangouts, Facebook, FTP server directory)

2. Please provide your views about the technology preparation (training) approach followed before using the tools for learning purposes.
3. Aside of the tools suggested, what other means did you choose to communicate/collaborate with your team or other community members?
4. Please provide your thoughts on face-to-face and/or remote communication/collaboration in the community?
5. How did these tools support or impede your learning (individual/collaborative)? Please provide an example.
6. How did these tools support or impede your creative processes and/or outcomes (individual/collaborative)? Please provide an example.
7. How did you go about solving any (technology-related) issues you encountered?
8. Apart from the adjustments already applied in the process (concerning technology tools), what else would you change or add to make things work more efficiently and to also generate better (creative) outcomes? Any suggestions are welcomed.

Social

1. What were the pros and cons of socially participating and collaborating with others in the community (regarding your learning)?
2. What do you think were the major challenges faced in dealing with alumni mentors and clients in the community?
3. How do you think the CoP feedback influenced your team processes?
4. Did you agree/disagree with the feedback you received and why?
5. How did you address the feedback as a team? Can you provide an example?
6. Following your CoP exchanges and the feedback you received so far, how do you think this has affected your work (outcomes) in general?
7. What are your thoughts regarding the sentiment and behavior of community members, did they feel connected and comfortable or distant and awkward with/to each-other? Please explain why.
8. How do you perceive your social capabilities (communication/collaboration) following your (semester-long) participation in the CoP?

Epistemic

1. How did you share the labor that resulted from your academic and CoP-based responsibilities?
2. Please talk a little about how you worked in team-based or community-wide cases (i.e. individually/collectively, collocated/remotely, synchronously/asynchronously)
3. What are the important differences (pros and cons) in learning between this approach (CoP) and other modules you have attended throughout your course?
4. How well/bad did you collaborate with the external members of the community, especially within the context of your project work?
5. What were the learning benefits or challenges while working with real projects and clients, while being guided by alumni mentors in the community? How did you handle them (i.e. possible issues that arose)?
6. What effects did the prospect of (industrial) expert evaluation on your outcomes have on you (i.e. emotional, motivational) and your work processes?
7. To what extent did interaction with CoP members affect your knowledge gains, creative processes and outcomes, as an individual, a team, or a class of students, designers and prospective professionals? (pointers for self-efficacy, confidence, creativity, collaboration, vocational relevance, and identity in the discussion)
8. How would you (now) evaluate yourself (as a prospective professional designer) and your work (design/creative outcomes) following your recent experiences with industry stakeholders?

Appendix IV

Informed Consent Form for video recordings in the study (semester 1)

As a participant in this study, I agree to being videotaped for the purpose of observing the collaboration within my team as well as a means of verifying results from other data collected for modules PGT340 and PGT341 (Fall and Spring semesters). I am aware that I may withdraw this consent at any time without penalty, at which point, the videotape will be erased. I am also aware that this data will not be used for marking purposes, or shared with any other parties, will be strictly kept within the possession of the researcher (instructor) for analysis purposes and following that, will be destroyed at the end of this research.

Researcher's Signature ______________________________ Date ______________

Researcher's Title ____________________ Department _________________________

Appendix V

Sample of initial email communication between faculty and industry stakeholders (industrial mentors) as an initial declaration of collaboration interest (semester 1)

Email: Potential collaboration for Web Design & Development prototype project

Dear (client name),

I am reaching out to you this new academic year, regarding the possibility of conducting a project, as part of a joined effort between your organization and our 3rd year Web Design & Development students.

This collaborative project can take the form of a 'proof of concept', delivered at the end of semester 1 (December 2017) - concerning a new proposal or idea that you would like to see visually and interactively materialize, prior to proceeding with its development.

The project will also continue with a possible conclusion on a functional solution, using on a professional Content Management Platform (i.e. WordPress) in Semester 2 (April 2018), however, that will not require considerable effort or commitment from your end, should you not wish to do so. Please note that we cannot guarantee that the resulting student work will present satisfactory quality, of a level that is typically required in the industry.

If you are interested in the above, kindly be reminded that one of your employees or collaborators will need to be assigned as a liaisons person from your side, for project progress monitoring and generic communication with the students. Your timely approvals and feedback is requested. We foresee this to happen via online means of communication (feedback forum, social network group, email, or conference calls), approximately about 5 times throughout the course of the semester. These are:

- Initial requirements gathering (briefing - September)
- Low fidelity prototypes (sketches - October)
- High fidelity prototypes (high-quality visuals - October/November)
- Interactive website prototype beta version
- Final interactive website prototype (December - final evaluation & feedback)

Please note that the deliverable dates will be provided to you at the beginning of the semester. You will usually have 4-5 days to respond, following each date. Please note that this period has to be diligently met, so that students can move on with their coursework and consecutive deliverables normally.

There will be a total of two different teams working on the same project (from different groups), so this can produce a wider range of resulting prototypes for you.

Should this be of interest for you, please let us know at your earliest convenience, in order to proceed with the necessary arrangements.

Thanking you in advance,

(researcher's/instructor's name)

Department of Multimedia and Graphic Arts

Cyprus University of Technology

Sample of initial email communication between faculty and alumni (alumni mentors) as an initial declaration of collaboration interest (semester 1)

Dear (alumni mentor name),

we are contacting you in order to inquire if you would be interested to contribute to our Web Design & Development module – by acting as a virtual 'mentor' for 3rd year students, and becoming a member of our online Community of Practice (further details will be sent to you later).

We would like some of our *alumni*, as young web design/development *practitioners* in the field to share their expertise by providing regular feedback on our students' work. More specifically:

- all work will be posted online (on a digital portfolio platform i.e. Behance)
- feedback is required at 4 (1-2 week) intervals throughout the semester (
- feedback can be provided at your own time and pace (asynchronous) as long as it fits within the course schedule that will be sent to you

The experiment focuses on the multimedia- group of students, who will be divided into teams, so this will generate a total of 4 to 5 different projects. We do not see this being a very laborious task for a person with your background and expertise. Your design, technical, and user-experience skills, as well as the work you have produced so far, is highly valued, it would therefore be very beneficial to have you contribute to our course as an industrial/alumni mentor. Being a young professional, it may also be an interesting prospect for you to add academic mentoring experience to your resume.

Please know there is absolutely no problem if you decide not to participate in this initiative - your decision is well understood and respected. On the other hand, if you decide to get on board with this, we will need the following from you:

- Full Name
- Email
- Title
- Academic qualifications (short paragraph / max 50-80 words)
- Work experience (short paragraph / max 50-80 words)

- A personal statement - i.e. why you are doing this, what you are hoping for, and anything you wish to say which you deem as valuable for learners

Thanking you in advance,

(researcher's/instructor's name)

Department of Multimedia and Graphic Arts

Cyprus University of Technology

Sample of initial email communication between faculty and alumni (industrial expert) as an initial declaration of collaboration interest (semester 1)

Dear (industrial expert name),

We hope you our email finds you well.

We are contacting you to enquire whether you would like to support our Web Design and Development modules as an expert, by evaluating student work at the end of the semester and providing feedback based on your extended professional knowledge and experience in the industry. You will also be asked to register and participate in our online Community of Practice (further details will be sent to you later).

This is part of an initiative which aims to create a constructive dialogue between industry and education in the Web Design and Development discipline, in hope of helping graduates to develop aptitude, skills and competencies to meet real-world professional demands today. We value your background, expertise and work and would appreciate your help to make this possible.

We also acknowledge that time is limited due to your busy schedule, so this intervention has been designed, with that in mind. Your input is limited to a *one-time only* rating survey and feedback contribution. More specifically, there will be a total of 10 groups of students working on 10 different projects (websites) throughout the fall semester. In week 13 (last week of November 2017), you will be asked to rate these 8 projects based on some pre-determined questions, and to provide constructive feedback for the work through an online form. We estimate this to take approximately 1,5 - 2 hours' worth of your time.

Your contribution will be of great value, as the assessment criteria will be authentic and representative of real-world practice situations. We believe that this prospect (in conjunction with other interventions) will be a positive learning motivator for our 3rd-year students, who are soon to graduate from university.

Please know there is no problem if you decide not to participate in this initiative - your decision is well understood and respected. On the other hand, if you decide to participate, we will need the following from you:

- Full Name
- Email
- Title
- Academic qualifications (short paragraph / max 50-60 words)
- Work experience (short paragraph / max 50-60 words)
- Company name (optional)
- Photo (optional)

I will be contacting you with instructions about the evaluation process later on in the semester.

Thanking you in advance,

(researcher's/instructor's name)

Department of Multimedia and Graphic Arts

Cyprus University of Technology

Appendix VI

Sample of team's Behance feedback history

Team B

Sitemap

Alumni mentor 1

Notes: Having filters will help your visitors to follow up your site content. Also it will save time for them (which is important) and will create easy content search.

Register Form: Good decision to provide the option 'Guest' , for a lot of users (mostly on mobile devices) creating a new account is extra effort and some of them quit the process. Giving them the option to complete the task without to put extra effort is always a good idea.

The only disadvantage is that if your visitor create account - you collect data. If they act as 'Guests' there are not extra data for your audience.

Attention:1

Need to make this process easy and safe at the same time. Just my suggestion is to have in mind that the visitor/user needs to select payment method easy.

Client 1

HTA/ φίλτρα δραστηριοτήτων:

Στο "Παιδιά & *Νεοι" + "νηπιαγωγείο-προ δημοτική". Η υποκατηγορία "Καλοκαιρινή Περίοδος" χωρίζεται σε "Κατασκηνώσεις" (πάνω από 1 μέρες), και "Μονοήμερες εκδρομές" με υποκατηγορίες συλλογής του κοινού «ΑΠΟ: ξενοδοχεία» και «ΑΠΟ: σπίτια».

Η κατηγορία «Ενήλικες»: 2 υποκατηγορίες «ΑΠΟ: ξενοδοχεία» και «ΑΠΟ: σπίτια». Το 2ο περιλαμβάνει κοινές κατηγορίες με την παιδική ενότητα («Σαββατοκυρίακα» (1ημερο&2ημερο), «Απογεύματα καθημερινές», & «Κατασκηνώσεις»)

Sitemap/ δενδροδιάγραμμα έργου:

+ News category για καταγραφή των προηγούμενων events

Το tab που θα εμπεριέχει τις υποκατηγορίες «Τηγανοκίνηση» και «Green Cluster» ονομάζεται «Projects» & άλλο ξεχωριστό tab ως About.

Instructor

It is better to separate the two and provide a title:

a) sitemap and b) HTA for activities

2) what happens after you sign-in? is there a members section? what pages are there, what can members do there?

Low Fidelity Prototype

Client 1

Μπράβο, πολύ προσεγμένη και περιεκτική δουλειά!
Μερικές παρατηρήσεις:
-Το Gallery και το News να είναι διαχωρισμένο σε 2 ξεχωριστές κατηγορίες.
-Μόνο ένα είδος λογαριασμού (μέλος) αλλιώς ως guest
-Προσθήκη επιλογής για άλλη μια εναλλακτική διεύθυνση
-Τι βλέπει στην κατηγορία "Μάθε για εμάς"; Ποιά η δομή;

Alumni mentor 3

4. Gallery

- Same comments as below (3).

Alumni mentor 3

2. Προφίλ μέλους

- Your colour palette has changed here. Try to keep the colors consistent. Also try to distinguish the secondary vertical menu from the right panel.

3. Δραστηριότητες

- It looks like a different website. Suddenly, the top menu has changed. This should be kept consistent/identical on every page.

- Good use of breadcrumbs

- Why do you use Greek for the main content and English for the buttons and the sign up link? Choose one language and provide an option for international users to change between languages.

- Keep the word spacing equal. (choose a different text alignment to avoid these huge spacings between words, this makes the text difficult to read).

- The form text inputs are identical to the submit buttons. This can cause confusions to most of the users. Try to make the inputs look like inputs and the buttons look like buttons.

- Avoid adding a text with a font size smaller than 16pt, unless it is not so significant for users to read (e.g. footer info, copyrights, etc.). Keep in mind that there are users with limited capabilities. Try to design for all.

1. Αρχική σελίδα

- As a user, I would expect to view an interactive and informative slideshow with nice looking images and key information regarding the objectives of OEA. Such a slideshow could also include links to specific and important sections of the website that you would expect the user to visit.

- I like the use of colours and fonts, however, I would prefer less styling. For example, drop shadows are not necessary for this website. Sometimes less is more. :) Keep it simple and elegant, with nice typography and colour choices.

- Make sure that your links and buttons are clearly distinguishable from the other text.

Alumni mentor 1

User profile:

Sections can be separated with gray line and titles.

Simplify the menu. Will suggest to try gray/carbon cray text colors, Font: Roboto.

Activities can be placed also under the profile info (now look empty.

Need to add: Sign Out option and provision for Delete Account

User Profile:

Left menu: Allow me to suggest the following order:

- Notifications (it's good to have them there, optional you can display them as Facebook, on

user's Avatar.

- Favorites (Good choice for having counter indicator)

- Activities (Very good decision to add this, and the 'Cancel' button!

- Profile (on Edit mode to change password, avatar, Profile details etc)

- Settings : General settings (includes Profile settings like avatar, name etc & Account Settings like passwords, email etc.) and Payment Settings.

Alumni mentor 1

Contact page:

Writing tone is a very important part of your site. This should be same at any section - consistency.

Here you can read more about this: https://material.io/guidelines/style/writing.html#writing-tone

'Text box' - it will be more user friendly to have text box value 'Write your message here' for example. This effect the mood of our visitors.

'ONOMA' - "Ονομα : try to avoid the Caps Lock. Remember: 'Be friendly, respectful, and focus on the user' - Google Material Design Guides

!Just a reminder: try to avoid different color on each section. Visual consistency. Same button styles in each button.

Alumni mentor 2

Previews Activities:

Try to use icons (where is possible) than the text. Allow me to suggest to use greater than sign, than the text 'περισσότερα' this will be easy to see and to interact with, on mobile devices.

Try darker background than the light blue. Because the images you are going to have, work as 'pixel puzzle' because there a lot of colors, so you need strong background to provide bigger contrast to the image holders (events thumbnails)

Alumni mentor 2

Previews Activities:

Good to show the previous events, in that way you will increase the interesting for the events, to your new visitors. Good choice to use the carousel transition. Like the idea of having image thumbnails. And the way how the text is showed.

Attention: Having image as background for the 'more' button can make it visually 'busy' and specially on small screens. Also need to pay attention on the interactive area.

Is good solution to have flat color background than an image (if you want o have background in any case).

Alumni mentor 2

Upcoming activities:

The orange line indicator (on the calendar) , how will respond when there is an event on 19/November for example? On mobile devices as well.

If there are two events - how they will be displayed?

Those are some scenarios that maybe can happen and the response needs to be predicted.